R.B.

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(*Recognosce notum, ignotum inspice*)

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Edited by

CARLETON REA and J. RAMSBOTTOM

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THE SELBY FORAY.

9th–14th September, 1918.

The twenty-second annual week's Fungus Foray was held at Selby, from September 9th to September 14th, 1918. Until immediately before the Foray the weather unfortunately had been very dry, and the harvest of fungi was therefore smaller than had been expected in such a favourable locality. Microfungi were fairly varied. As a rule these follow quickly after rainy weather has set in.

The meeting was held in conjunction with that of the Yorkshire Naturalists' Union, and the latter, with a few members of the British Mycological Society, began work on the previous Saturday, September 7th. Bishop's Wood, Camblesforth, Cliffe Common and Staynor Wood were visited, and consequently a number of fungi had been collected and laid out for inspection by the time the majority of the party assembled.

The headquarters were at the Londesborough Arms Hotel, where a large room was available for holding meetings and exhibiting the specimens. Here on Monday evening, September 9th, Dr. H. Wager opened the proceedings by delivering an interesting and suggestive popular address on "Fungi" to a large audience composed of members of both Societies and of the Selby Natural History Society. After the lecture members examined the various exhibits which had been brought. Mr. H. J. Wheldon showed a small collection of water-colour drawings of Lichens, Ascomycetes, and Uredineae. Miss E. M. Blackwell had brought from the sand-dunes near Liverpool a tufted form of *Mycena acicula*, and Miss C. A. Cooper showed specimens of *Tricholoma sordidum* and *Lentinus lepideus* from Castleford.

On Tuesday morning the party booked by the 11.23 a.m. train to Burton Salmon. During an hour's wait at Church Fenton, necessitated by the vagaries of the train service, a few common species were found. On arrival at Burton Salmon the party at once set out for Byram Park, permission to visit which had been given by Sir John Ramsden. The grounds were thoroughly explored, and a fair number of interesting fungi secured, particularly pasture-loving Agarics. *Lepiota Bucknallii*, easily recognised by its smell of gas-tar, *Tricholoma acerbum*, *Pluteus ephebius*, *Leptonia sericella*, *L. incana*, *L. chalybea*,

Inocybe Godeyi, I. rhodiola, Psaliota villatica, Corticium lactescens, exuding white latex when perfectly fresh and in good condition, *Odontia fimbriata,* and *Clavaria rosea* (the latter collected by Col. Barr), were amongst the most interesting species identified in the field. Subsequently *Galactinia Howsei**, new to Britain, and *Orbilia curvatispora,* first recorded by Dr. Bayliss Elliott in 1917, were determined. Miss A. Lorrain Smith reported finding *Stysanus cybosporus* Sacc., which has been previously recorded from near Birmingham. The tufts are greenish-grey in colour and of lax growth; the fertile hyphae gradually develop long strings of cube-like conidia.

On the following day, after a morning's work in examining specimens, the afternoon was spent in exploring the woods at Escrick. Fewer fungi of interest were found here than on the previous day, the larger fungi especially being represented mainly by common species. Among the smaller forms, however, a few rare species were obtained. Miss A. Lorrain Smith collected for the first time in Britain *Hypochnus umbrinus*†, one of the darkest of the species of Hypochnus, and noteworthy for its very compact hymenium. Some fine specimens of *Peniophora aurantiaca* and of *Pistillaria quisquiliaris* occurred, and Dr. Bayliss Elliott afterwards reported having found *Urceolella puberula* growing on larch, an unusual host. Among microfungi the best find was *Arthroderma Curreyi* Berk., the minute golden-yellow fluffy perithecia of which grew in abundance on vegetable debris; it is an interesting and very rare fungus. *Menispora ciliata,* with its very distinctive spores, ciliate at each end, formed a felt of brown hyphae on the bark of a decaying branch. With it was associated *Dactylella ellipsospora*; the long slender conidiophores with a somewhat massive spore swaying to and fro with any current of air were easily visible with a hand lens. *Mortierella candelabrum* also appeared on the same branch. *Botrytis argillacea,* another unusual mould, formed a dense, dull brownish felt on dead bark; the stoutish short branches are subverticillate, and terminate in a knob covered with small projections on which the spores are borne.

On Wednesday the party took the 12.35 p.m. train to Garforth, where they were met by the Rev. R. H. Harvey, who acted as leader. The programme was to visit Parlington Park and Lotherton, by permission of Col. Gascoigne, but as so much of interest was found there was not time to visit the latter place. This was by far the best day of the week both for the numbers and interest of the fungi found. *Lepiota castanea* with its curious "projectile-shaped" spores, *Tricholoma immundum,*

* For description see p. 133.

† For description see p. 132.

THE BRITISH MYCOLOGICAL SOCIETY. SELBY FORAY, 9TH TO 14TH SEPT. 1918

E. Blackwell R. H. Harvey R. F. Jones
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Marasmius pruinatus, Entoloma ameides, Leptonia incana, Coprinus picaceus, last found at Haslemere in 1912, and *Boletus porphyrosporus* were among the best of the higher fungi. A charming group of the light ochraceous sporophores of *Cyphella cernua,* new to Yorkshire, grew on branches of *Sambucus nigra.* On the branches of the same tree were numerous groups of the perithecia of *Gibberella pulicaris,* distinguished by the beautiful blue colour as seen in a thin section. The minute yellow pycnidia of *Zythia mercurialis* Kickx, dotted the leaves of the Dog Mercury; it is a new record for Britain*. Other moulds, such as *Botrytis cinerea, Cladosporium, Penicillium,* etc., were abundant everywhere, and are included in the Foray list.

Some of the moulds were only noted after placing the vegetable substratum in a moist chamber for a time. On some of the debris from Parlington Park there appeared after a lapse of some weeks a beautiful growth of one of the Myxobacteriaceae. It agrees in colour and in cocci with *Myxococcus pyriformis,* recorded in Trans. Brit. Myc. Soc. III, 1909, p. 82. The form is slightly different, as some of the bodies of bacteria rest on a broader basis than those of previous gatherings.

Staynor Wood, visited on the Friday, yielded little of interest. *Russula azurea, R. punctata* and *Collybia xanthopus* occurred, the latter very close to *C. dryophila* and perhaps only a form of that species, distinguished by its larger size and different shape. *Pluteus nanus* var. *lutescens,* with its yellow stem, and the large *Galera ovalis* were also noted. *Hypochnus isabellinus,* new to Britain†, was collected and handed to Miss A. Lorrain Smith as a mould. It is distinguished among the species of Hypochnus by its isabelline colour, so that at first sight it might suggest a Botrytis. Examination with the microscope, however, at once reveals that it is a Basidiomycete. Very few microfungi occurred on this day, and none of any special interest.

In the evenings, as usual, papers were read and exhibits shown. Dr. Paul's Presidential Address, "On the Earlier Study of Fungi in Britain," was listened to by a large and appreciative audience. Dr. H. Wager gave two interesting papers, on "Spore Coloration in the Fungi," and on "A Fluorescent Colouring-matter from *Leptonia incana.*" As *L. incana* was found during the Foray, Dr. Wager was able to demonstrate from fresh specimens. Mr. H. J. Wheldon read "Observations on some Sand-dune Fungi," and exhibited a specimen of *Ustilago hypodytes* on *Elymus arenaria,* sent by Mr. J. A.

* For description see p. 155.

† For description see p. 133.

Wheldon from the Formby sand-dunes. Mr. A. D. Cotton contributed notes on "Some New or Rare British Fungi," specimens of which he exhibited. The fungi in question were Onion Smut (*Urocystis cepulae*), Oak Mildew (*Microsphaera alphitoides*) on coppiced Beech, and an unidentified fungus, suggesting one of the Ustilagineae, causing large galls on the roots of *Lamium album*.

At the business meetings, Officers and Council for the year 1919 were elected, and a draft of revised Rules was prepared. Full notice of the changes made has already been given to all members. A list of Officers and Council appears on p. ii of the cover. In recognition of his past services to the Society, Mr. Carleton Rea was unanimously elected an Honorary Member. He is the third Honorary Member, and the first British mycologist to whom the honour has been granted.

At the concluding meeting votes of thanks were passed to Mr. W. N. Cheesman, for his energy and kindness in arranging for the comfort of the party, to Dr. Paul for presiding, and to the various proprietors and factors who had given facilities for visiting their estates.

The Hon. Secretary is much indebted to Miss A. Lorrain Smith for assistance in drawing up the above report, and has to thank in addition Mr. Carleton Rea, Mr. A. A. Pearson, Mr. H. J. Wheldon, and Dr. Bayliss Elliott for help in compiling the subjoined list of species gathered.

As a rule, where no locality is specified, the species listed was found generally in all the places visited.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

By. = Byram Park; *B.W.* = Bishop's Wood; *Cl.* = Cliffe Common; *C.* = Camblesforth; *S.* = Staynor Wood; *P.* = Parlington Park; *E.* = Escrick.

Amanita phalloides (Vaill.) Fr., mappa Fr., muscaria (Linn.) Fr., rubescens (Pers.) Fr., strobiliformis Vitt., *P.*

Amanitopsis vaginata (Bull.) Roze, fulva (Schaeff.) W. G. Sm.

Lepiota procera (Scop.) Fr., *E.*, rachodes (Vitt.) Fr., *E.*, acute-squamosa (Weinm.) Fr., *E.*, castanea Quél., *P.*, felina (Pers.) Fr., *E.*, cristata (A. & S.) Fr., granulosa (Batsch) Fr., *S.*, amaianthina (Scop.) Fr., *C.*, Bucknallii Berk. & Br., *By.*

Tricholoma albobrunneum (Pers.) Fr., *B.W.*, rutilans (Schaeff.) Fr., *P.*, immundum Berk., *P.*, terreum (Schaeff.) Fr.,

B.W., *By.*, *P.*, argyraceum (Bull.) Fr., *P.*, cuneifolium Fr., *By.*, personatum Fr., *S.*, melaleucum (Pers.) Fr., *P.*

Clitocybe clavipes (Pers.) Fr., *By.*, odora (Bull.) Fr., *By.*, rivulosa (Pers.) Fr., *By.*, infundibuliformis (Schaeff.) Fr., flaccida (Sow.) Fr., *C.*, ditopus Fr., *P.*, *S.*, fragrans (Sow.) Fr., *B.W.*, *By.*, *P.*

Laccaria laccata (Scop.) Berk. & Br.

Collybia radicata (Relh.) Berk., *By.*, *P.*, *S.*, platyphylla Fr., *Cl.*, *B.W.*, *E.*, fusipes (Bull.) Berk., *P.*, maculata (A. & S.) Fr., *C.*, *E.*, distorta Fr., *E.*, velutipes Fr., *By.*, confluens (Pers.) Fr., *Cl.*, *B.W.*, *E.*, *P.*, cirrhata (Pers.) Fr., *B.W.*, *E.*, *S.*, tuberosa (Bull.) Fr., *E.*, xanthopus Fr., *S.*, dryophila (Bull.), *E.*, *P.*, *S.*, aquosa (Bull.) Fr., *B.W.*, *E.*, *S.*

Mycena olivaceo-marginata Mass., pura (Pers.) Fr., *By.*, *P.*, rugosa Fr., *Cl.*, *B.W.*, *E.*, galericulata (Scop.) Fr., inclinata Fr., *E.*, ammoniaca Fr., *By.*, *P.*, *S.*, vitilis Fr., *Cl.*, *S.*, acicula (Schaeff.) Fr., *P.*, haematopus (Pers.) Fr., *Cl.*, *B.W.*, *P.*, sanguinolenta (A. & S.) Fr., galopus (Pers.) Fr., var. nigra Fl. Dan., var. alba Fl. Dan., rorida Fr., *S.*, stylobates (Pers.) Fr., *C.*, *E.*, tenerrima Berk., *B.W.*, *P.*

Omphalia fibula (Bull.) Fr., var. Swartzii Fr., *E.*, gracilis Quél., *P.*

Pleurotus ostreatus (Jacq.) Fr., *P.*, applicatus (Batsch) Berk., *C.*, *By.*, *E.*, *P.*

Hygrophorus chrysodon (Batsch) Fr., *S.*, pratensis (Pers.) Fr., *By.*, *E.*, virgineus (Wulf.) Fr., *By.*, niveus (Scop.) Fr., *Cl.*, ceraceus (Wulf.) Fr., *B.W.*, coccineus (Schaeff.) Fr., *By.*, conicus (Scop.) Fr., *By.*, *E.*, *P.*, psittacinus (Schaeff.) Fr., *By.*, *E.*, *P.*

Lactarius turpis (Weinm.) Fr., blennius Fr., *By.*, pallidus (Pers.) Fr., *By.*, quietus Fr., rufus (Scop.) Fr., *Cl.*, *E.*, glyciosmus Fr., *E.*, serifluus (DC.) Fr., *E.*, subdulcis (Pers.) Fr., *By.*, *S.*

Russula nigricans (Bull.) Fr., *Cl.*, *S.*, adusta (Pers.) Fr., *P.*, chloroides (Krombh.) Bres., *P.*, mustelina Fr., *Cl.*, *S.*, furcata (Pers.) Fr., *B.W.*, *S.*, virescens (Schaeff.) Fr., *E.*, lepida Fr., *Cl.*, *S.*, atropurpurea (Krombh.) Maire, *E.*, xerampelina (Schaeff.) Fr., *Cl.*, *B.W.*, vesca Fr., *Cl.*, *E.*, *S.*, cyanoxantha (Schaeff.) Fr., *P.*, *S.*, pectinata (Bull.) Fr., *E.*, foetens (Pers.) Fr., *Cl.*, *B.W.*, *E.*, subfoetens W. G. Sm., *By.*, fellea Fr., *By.*, *S.*, emetica (Schaeff.) Fr., *E.*, azurea Bres., *S.*, ochroleuca (Pers.) Fr., fragilis (Pers.) Fr., var. nivea (Pers.) Cooke, *E.*, punctata Gill., *S.*, lutea (Huds.) Fr., *S.*

Nyctalis parasitica (Bull.) Fr., *E.*

Marasmius peronatus (Bolt.) Fr., *B.W.*, *E.*, *S.*, oreades (Bolt.) Fr., ramealis (Bull.) Fr., *Cl.*, *B.W.*, *S.*, rotula (Scop.) Fr., *C.*, androsaceus (Linn.) Fr., *C.*, *E.*, *S.*, pruinatus Rea, *P.*

Crinipellis stipitarius (Fr.) Pat., *C.*

Pluteus cervinus (Schaeff.) Fr., ephebius Fr., *By.*, salicinus (Pers.) Fr., *Cl.*, *P.*, nanus (Pers.) Fr., *E.*, var. lutescens Fr., *By.*, *S.*

Entoloma ameides Berk. & Br., *P.*, jubatum Fr., *C.*, *E.*, griseocyaneum Fr., *By.*, sericeum (Bull.) Fr.

Clitopilus prunulus (Scop.) Fr., *By.*

Leptonia lampropus Fr., *By.*, *E.*, chalybea (Pers.) Fr., *By.*, incana Fr., *By.*, *P.*, sericella (Fr.) Quél., *C.*, *B.W.*, *By.*

Nolanea pascua (Pers.) Fr., proletaria Fr., *Cl.*, *B.W.*, *P.*, *S.*, papillata Bres., *By.*

Eccilia griseorubella (Lasch) Fr., *E.*

Claudopus variabilis (Pers.) W. G. Sm., *C.*

Pholiota ombrophila Fr., *By.*, squarrosa (Müll.) Fr., *P.*, spectabilis Fr., *Cl.* marginata (Batsch) Fr., *Cl.*, *S.*

Inocybe cincinnata Fr., *By.*, *S.*, rhodiola Bres., *By.*, fastigiata (Schaeff.) Fr., *E.*, Godeyi Gill., *By.*, rimosa (Bull.) Fr., *B.W.*, *By.*, *E.*, *S.*, duriuscula Rea, *B.W.*, asterospora Quél., *Cl.*, proximella Karst., *By.*, geophylla (Sow.) Fr. conformata Karst., *B.W.*

Hebeloma fastibile Fr., *P.*

Flammula sapinea Fr., *Cl.*, *B.W.*, *By.*, *P.*, *S.*, alnicola Fr., *P.*

Naucoria sobria Fr., *By.*, escharoides Fr., *S.*, graminicola (Nees) Fr., *S.*

Pluteolus aleuriatus Fr., *C.*, *B.W.*, *By.*

Galera tenera (Schaeff.) Fr., *C.*, *By.*, *E.*, ovalis Fr., *S.*, hypnorum (Schrank) Fr., *C.*, *B.W.*, *E.*

Tubaria furfuracea (Pers.) W. G. Sm., crobulus Fr., *P.*, *S.*, inquilina Fr., *B.W.*

Crepidotus mollis (Schaeff.) Fr., *P.*

Cortinarius (Dermocybe) lepidopus Cooke, *B.W.*, (Telamonia) hinnuleus (Sow.) Fr., *Cl.*, *E.*, *P.*, *S.*, rigidus (Scop.) Fr., *E.*, *P.*, (Hydrocybe) castaneus (Bull.) Fr., *S.*

Paxillus involutus (Batsch) Fr., panuoides Fr., *P.*

Psaliota villatica (Brond.) Fr., *By.*, arvensis (Schaeff.) Fr., *S.*, xanthoderma (Genev.) W. G. Sm., *By.*, campestris (Linn.) Fr., sylvicola (Vitt.) Fr., *By.*

Stropharia aeruginosa (Curt.) Fr., *E.*, *P.*, *S.*, squamosa (Pers.) Fr., *P.*, semiglobata (Batsch) Fr., coronilla (Bull.) Fr., *By.*, *P.*

Hypholoma capnoides Fr., *C.*, fasciculare (Huds.) Fr., epixan-

thum Fr., *C.*, velutinum (Pers.) Fr., appendiculatum (Bull.) Fr., *C.*, *By.*, pilulaeforme (Bull.) Fr., *By.*, *E.*, *P.*, hydrophilum (Bull.) Fr., *Cl.*, *B.W.*, *E.*, *P.*, *S.*

Psilocybe uda (Pers.) Fr., *C.*, *S.*, bullacea (Bull.) Fr., *B.W.*, semilanceata Fr., foenisecii (Pers.) Fr.

Psathyra corrugis (Pers.) Fr., *Cl.*, *By.*, *P.*, *S.*, obtusata Fr., *P.*, fibrillosa (Pers.) Fr.

Bolbitius titubans (Bull.) Fr., *Cl.*

Coprinus atramentarius (Bull.) Fr., *By.*, *S.*, *E.*, *P.*, picaceus Fr., *P.*, cinereus (Schaeff.) Fr., *B.W.*, *E.*, *P.*, *S.*, niveus (Pers.) Fr., *Cl.*, *By.*, *P.*, micaceus (Bull.) Fr., *E.*, *P.*, radiatus Fr., *B.W.*, plicatilis (Curt.) Fr., *By.*, *E.*, hemerobius Fr., *By.*, ephemerus Fr., *By.*

Panaeolus sphinctrinus Fr., *C.*, *E.*, campanulatus (Linn.) Fr., *By.*, *E.*, *P.*, papilionaceus (Bull.) Fr., *E.*, *S.*

Anellaria separata (Linn.) Karst., *Cl.*, *E.*, *P.*

Psathyrella gracilis (Pers.) Fr., *By.*, *E.*, *P.*, *S.*, hiascens Fr., *Cl.*, atomata Fr., *C.*, *By.*, *E.*, crenata (Lasch) Fr., *By.*, disseminata (Pers.) Fr.

Gomphidius viscidus (Linn.) Fr., *By.*

Boletus luteus (Linn.) Fr., *B.W.*, elegans (Schum.) Fr., *B.W.*, *E.*, *P.*, chrysenteron (Bull.) Fr., *B.W.*, *S.*, versicolor Rost., *Cl.*, subtomentosus (Linn.) Fr., *E.*, *S.*, pruinatus Fr., *By.*, edulis (Bull.) Fr., *S.*, luridus (Schaeff.) Fr., *By.*, porphyrosporus Fr., *P.*, scaber (Bull.) Fr., *Cl.*, *E.*, felleus (Bull.) Fr., *E.*, *S.*

Strobilomyces strobilaceus (Scop.) Berk., *By.*

Fistulina hepatica (Huds.) Fr., *C.*, *E.*, *P.*

Polyporus rufescens (Pers.) Fr., *E.*, squamosus (Huds.) Fr., *By.*, *P.*, hispidus Fr., *C.*, *E.*, *P.*, rutilans (Pers.) Fr., *B.W.*, adustus (Willd.) Fr., *C.*, *By.*, *S.*, caesius (Schrad.) Fr., *P.*, betulinus (Bull.) Fr., *By.*, *P.*

Fomes applanatus (Pers.) Wallr., *B.W.*, *By.*, *P.*, nigricans Fr., *B.W.*, igniarius Fr., *B.W.*, connatus Fr., *S.*, annosus Fr., *C.*, *P.*, ferruginosus (Fr.) Mass., *C.*

Polystictus versicolor (Linn.) Fr., velutinus Fr., *By.*

Poria eupora Karst., *By.*, hymenocystis Berk. & Br., *P.*

Daedalea quercina (Linn.) Fr., *C.*, *E.*

Merulius lacrymans (Wulf.) Fr., *Cl.*

Hydnum udum Fr., *By.*

Caldesiella ferruginosa (Fr.) Sacc., *P.*

Irpex obliquus (Schrad.) Fr.

Odontia alutacea (Fr.) Quél., *By.*, fimbriata (Pers.) Fr., *B.W.*, *By.*, farinacea (Pers.) Quél., *B.W.*, *By.*, *P.*, *S.*

Grandinia granulosa Fr., *By.*, *P.*

Thelephora laciniata (Pers.) Fr., *C.*, *B.W.*, *E.*

Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr., *P.*, spadiceum (Pers.) Fr., *E.*, *P.*, sanguinolentum (A. & S.) Fr., *B.W.*, rugosum (Pers.) Fr., *S.*

Hymenochaete rubiginosa (Schrad.) Lév., *B.W.*

Corticium laeve (Pers.) Fr., *P.*, arachnoideum Berk. & Br., *C.*, Sambuci (Pers.) Fr., botryosum Bres., *S.*, subcoronatum von Hoehn. & Litsch., *B.W.*, *P.*, *S.*, confluens Fr., confine Bourd. & Galz., *By.*, *S.*, sulphureum (Pers.) Bres., *C.*, *P.*, praetermissum (Karst.) Bres., *By.*, lactescens Berk., *By.*, albostramineum (Bres.) Wakef., *C.*, *P.*

Peniophora subalutacea (Karst.) von Hoehn. & Litsch., *By.*, velutina (DC.) Cooke, *C.*, *P.*, setigera (Fr.) Bres., *C.*, pubera (Fr.) Mass., *C.*, *By.*, *P.*, aurantiaca Bres., *E.*, cinerea (Fr.) Cooke, *By.*, *P.*, quercina (Pers.) Cooke, *By.*, *B.W.*, *P.*

* Hypochnus umbrinus (Fr.) Quél., *E.* (new to Britain), *isabellinus Fr. (new to Britain), *S.*

Coniophora puteana (Schum.) Fr., *B.W.*, *By.*, *P.*, *S.*

Cyphella cernua Mass., *P.*, villosa (Pers.) Karst., *By.*

Clavaria cinerea (Bull.) Fr., *C.*, *E.*, *P.*, *S.*, cristata (Holmsk.) Fr., *C.*, *S.*, muscoides (Linn.) Fr., *By.*, *E.*, inaequalis (Müll.) Fr., *B.W.*, *S.*, persimilis Cotton, *By.*, vermicularis Fr., *By.*, fumosa (Pers.) Fr., *By.*, rosea (Dalm.) Fr., *By.*

Typhula erythropus (Bolt.) Fr., *S.*

Pistillaria quisquiliaris Fr., *E.*, pusilla Berk., *C.* (on poplar leaves).

Auricularia auricula-Judae (Linn.) Schroet., *C.*, *B.W.*, *P.*, *S.*

Exidia albida (Huds.) Bref., *P.*

Tremella mesenterica (Retz.) Fr., *S.*

Dacryomyces deliquescens (Bull.) Duby, *B.W.*, stillatus (Nees) Fr., *C.*, *By.*, *P.*, *S.*

Calocera viscosa (Pers.) Fr., *C.*, *P.*, cornea (Batsch) Fr., *Cl.*, *By.*, *P.*, *S.*

Phallus impudicus (Linn.) Pers., *C.*, *E.*, *P.*

Mutinus caninus (Huds.) Fr., *C.*, *B.W.*, *E.*, *P.*

Sphaerobolus stellatus (Tode) Pers., *B.W.*, *P.*, *S.*

Cyathus vernicosus (Bull.) DC., *E.*, *S.*, striatus (Huds.) Pers., *E.*, *P.*

Crucibulum vulgare Tul., *E.*, *P.*, *S.*

Bovista plumbea Pers., *By.*

Lycoperdon depressum Bon., *Cl.*, *E.*, pyriforme (Schaeff.) Pers., *B.W.*, *E.*, *P.*, umbrinum Pers., *E.*, perlatum Pers., *B.W.*, *P.*, giganteum (Batsch) Pers., *B.W.*

* For descriptions see pp. 132, 133.

Geaster fimbriatus Fr., *P.*
Scleroderma vulgare Hornem., *By.*, *E.*, *S.*, verrucosum (Bull.) Pers., *E.*
Puccinia Violae (Schum.) DC., *B.W.*, Malvacearum Mont., *B.W.*, obtegens (Linn.) Tul., *By.*, obscura Schroet. (Aecidium on *Bellis perennis*), *C.*, Poarum Niels. (Aecidium on *Tussilago*), *P.*, glumarum (Sch.) Erikss., *E.*, dispersa Erikss. & Henn., *E.*
Coleosporium Tussilaginis (Pers.) Kleb., *Cl.*
Sphacelotheca Hydropiperis (Schum.) de Bary, *S.*
Ustilago Avenae (Pers.) Jens., *E.*, *P.*
Podosphaera oxyacanthae (DC.) de Bary, *By.*
Sphaerotheca pannosa (Wallr.) Lév., *By.*
Microsphaera grossulariae (Wallr.) Lév., *E.*
Erysiphe communis (Wallr.) Fr., on *Circaea*, *P.*, *Heracleum*, *By.*, *Polygonum aviculare*, *C.*, cichoracearum (DC.) Fr., on *Lappa*, *By.*, *P.*, graminis (DC.) Fr., *By.*
Nectria cinnabarina (Tode) Fr., episphaeria (Tode) Fr., coccinea (Pers.) Fr., Peziza (Tode) Fr., *P.* (on *Polyporus squamosus*).
Hypocrea gelatinosa (Tode) Fr., *S.*
Hypomyces aurantius (Pers.) Fuck. (on *Polystictus velutinus*), *By.*, rosellus (A. & S.) Tul.
Claviceps purpurea (Fr.) Tul., *E.*
Cordyceps militaris (Linn.) Link, *B.W.*, with conidial stage also.
Gibberella pulicaris (Fr.) Sacc., *P.*
Chaetomium elatum Kunze.
Sordaria fimicola (Rob.) Ces. & de Not.
Sporormia intermedia Auersw., minima Auersw.
Leptospora ovina (Pers.) Fuck., spermoides (Hoffm.) Fuck.
Melanomma pulvis-pyrius (Pers.) Fuck.
Rosellinia aquila (Fr.) de Not., pulveracea (Ehrh.) Fuck.
Venturia inaequalis (Cooke) Aderh., *E.*, pirinum Aderh., *P.* (conidial stages).
Zignoella ovoidea (Fr.) Sacc., eutypoides Sacc. fide H. J. Wheldon (on hazel branch).
Leptosphaeria acuta (Moug. & Nestl.) Karst., vagabunda Sacc.
Ophiobolus porphyrogonus (Tode) Sacc.
Diaporthe (Chorostate) Taleola (Fr.) Sacc., on oak, (Tetrastaga) insignis Fuck., on *Rubus*.
Melanconis Alni Tul., stilbostoma (Fr.) Tul.
Diatrype stigma (Hoffm.) de Not., bullata (Hoffm.) Fr., *By.*, disciformis (Hoffm.) Fr., *P.*
Diatrypella quercina (Pers.) Nke., *E.*
Valsa populina (Pers.) Wint.

Eutypa lata (Pers.) Tul., Acharii Tul., flavovirescens (Hoffm.) Tul.
Hypoxylon multiforme Fr.
Daldinia concentrica (Bolt.) Ces. & de Not., *By.*, *P.*
Ustulina vulgaris Tul., *By.*
Xylaria polymorpha (Pers.) Grev., *By.*, Hypoxylon (Linn.) Grev.
Phyllachora graminis (Pers.) Fuck., *E.*, Junci (Fr.) Fuck.
Rhopographus Pteridis (Sow.) Wint.
Arthroderma Curreyi Berk.
Helvella crispa (Scop.) Fr., *By.*
Leptopodia elastica (Bull.) Boud., *S.*
Aleuria vesiculosa (Bull.) Boud., *E.*
Galactinia badia (Pers.) Boud., *E.*, * Howsei Boud., *By.* (new to Britain).
Ciliaria scutellata (Linn.) Quél., *P.*, setosa (Nees) Boud., *P.*
Cheilymenia dalmeniensis (Cooke) Boud., *P.*
Coprobia granulata (Bull.) Boud.
Ascobolus Crouani Boud., *S.*, stercorarius (Bull.) Schroet.
Taphrina aurea (Pers.) Fr., *C.*, on seedlings of *Betula.*
Leotia lubrica (Scop.) Pers., *By.*
Cudoniella acicularis (Bull.) Schroet., *E.*
Ombrophila alniella (Nyl.) Karst., *E.*
Coryne sarcoides (Jacq.) Tul., *C.*
Bulgaria inquinans (Pers.) Fr., *By.*, *P.*
Polydesmia pruinosa (Berk. & Br.) Boud., *E.*
Orbilia xanthostigma Fr., *C.*, *B.W.*, *E.*, *S.*, curvatispora Boud., *By.*
Hyalinia inflatula (Karst.) Boud., *By.*
Chlorosplenium aeruginosum (Oeder.) de Not., *P.*
Helotium epiphyllum (Pers.) Fr., *E.*, virgultorum (Wahl.) Karst., *B.W.*, *E.*
Dasyscypha nivea (Hedw. fil.) Sacc., *E.*, ciliaris (Schrad.) Sacc., *S.*
Trichoscypha calycina (Schum.) Boud., *E.*
Hyaloscypha hyalina (Pers.) Boud., *Cl.*, *C.*
Micropodia chrysostigma (Fr.) Boud., *E.*, aspidiicola (Berk. & Br.) Boud., *S.*
Urceolella puberula (Lasch) Boud., *E.*, on larch.
Mollisia benesuada (Tul.) Phill., *S.*, cinerea (Batsch) Karst.
Rhytisma acerinum (Pers.) Fr., punctatum (Pers.) Fr., *B.W.*, *E.*
Phytophthora infestans (Mont.) de Bary, *By.*
Peronospora parasitica (Pers.) Tul., *C.*
Spinellus macrocarpus (Corda) Karst., *By.* (on *Mycena inclinata* Fr.).

* For description see p. 133.

Pilobolus crystallinus (Wiggers) Tode, *Cl.*
Mortierella candelabrum van Tiegh. & le Monn., *E.*
Phoma herbarum West., *E.*, on stem of *Urtica.*
Cytospora ambiens Sacc.
Coniothyrium Hellebori Cooke & Mass.
Ascochyta Pisi Lib., *P.*
Septoria glumarum Pass., *By.*
Gloeosporium Ribis (Lib.) Mont. & Desm., *E.*
Melanconium zonatum Ell. & Ev., *By.*, on birch.
Dinemasporium gramineum Tul., *By.*
* Zythia mercurialis (Lib.) Kickx, *P.* (new to Britain).
Cylindrium Cordae Sacc.
Fusidium griseum Link.
Aegerita candida (Pers.) Fr., *C.*, *S.*
Cephalosporium acremonium Corda.
Trichoderma viride (Pers.) Fr.
Penicillium glaucum Link, candidum (Link) Fr.
Rhinotrichum repens Preuss., Thwaitesii Berk. & Br., *E.*, *S.*
Botrytis vulgaris Fr., cinerea (Pers.) Fr., argillacea Cooke, *E.*, pyramidalis (Bon.) Sacc.
Ramularia calcea (Desm.) Ces., *E.*, *S.*
Sepedonium chrysospermum Fr.
Acrostalagmus albus Preuss.
Gonatobotrys flava Bon.
Tricothecium piriferum Sacc.
Dactylella ellipsospora Grove, *E.*
Periconia pycnospora Fres.
Acremoniella atra Sacc.
Menispora ciliata Corda, *E.*
Cladosporium epiphyllum Mart., herbarum Link.
Brachysporium oosporum Sacc.
Helminthosporium gramineum Rabenh., *E.*
Dendryphium curtum Berk. & Br.
Macrosporium commune Rabenh.
Alternaria tenuis (Nees) Corda.
Isaria brachiata Schum.
Stysanus cybosporus Sacc., *By.*
Tubercularia vulgaris (Tode) Fr.
Dendrodochium citrinum Grove.
Volutella gilva Sacc., ciliata Fr., *By.*
Fusarium roseum Link, culmorum (W. G. Sm.) Sacc., *By.*
Epicoccum purpurascens Ehrenb.
Myxococcus pyriformis A. L. Smith, *P.*

* For description see p. 155.

MYCETOZOA FOUND DURING THE SELBY FORAY.

By Gulielma Lister, F.L.S.

The visit of the British Mycological Society to Selby proved a successful one for those of the party who were interested in Mycetozoa. Owing to the Yorkshire Naturalists' Society holding its meeting at Selby about the same time, although starting a few days earlier, and combined expeditions being taken, the number of days for collecting were more than usual, and extended from Saturday, September 7th, to Friday, September 13th.

Sufficient rain had fallen in the previous weeks to make the woods and heaps of dead leaves thoroughly moist, and the weather during the time of the foray was, on the whole, fair.

Osgoodby Woods, Camblesforth Wood and Bishop's Wood were visited before the main party arrived; and Mycetozoa were collected under the able guidance of Mr. W. N. Cheesman.

On Tuesday, September 10th, Byram Park, with its fine lawns, groups of living and felled beeches, as well as denser woodland, was searched. Large developments of *Dictydiaethalium plumbeum*, both mature and in rose-red plasmodium, were found on beech logs. On another prostrate beech, growths of purple-brown sporangia of *Dictydium cancellatum* were seen extending interruptedly for a length of about twelve feet. Another dead beech stump yielded a conspicuous cushion-like mass of translucent white plasmodium an inch across, which, on being carefully removed, developed in a few days into a fine growth of *Stemonitis fusca* var. *confluens*—a completely aethalioid form without trace of stalks or columellae. In the denser woodland, the rare *Lycogala flavofuscum* was found at the foot of a tall elm, looking so much like a big grey puff-ball, that it was mistaken for one by its finder and broken open. The aethalium measured an inch across, and was produced at the base on one side into a curious pale yellow stalk-like strand of hypothallus. Under large hollies, deep beds of decaying leaves afforded a favourable haunt for many Mycetozoa. Here were found *Craterium aureum, C. minutum, Diderma effusum, Didymium nigripes, D. Clavus, D. squamulosum* and

Lamproderma scintillans. Altogether twenty-four species were seen that day. On Wednesday, September 11th, the Escrick Woods were visited. These consisted of plantations of young sycamore and Scots pine, and also of extensive young birch woods having a dense undergrowth of bracken sheltering old decaying stumps of birch; further on was older mixed woodland. Although only eight species of Mycetozoa were collected, the list included *Colloderma oculatum*, recorded only once before in Yorkshire. It occurred in some abundance among moss and liverworts on old birch stumps; the shining dark-brown sporangia could hardly be detected without the aid of a lens, and even then were easily confused with the numerous minute beetle-mites (*Oribatidae*) that were slowly crawling about the same moss. Some of this moss brought indoors and kept moist has produced fresh crops of *Colloderma* sporangia up to the end of October. Parlington Park was visited on Thursday, September 12th, a rather gloomy and showery day, but affording the party a harvest of thirty-three species of Mycetozoa. The most noteworthy of these was perhaps *Physarum psittacinum*, on dead ash wood; it appears to be a completely summer species, and was found lingering on in a mouldy condition. *Badhamia panicea* and *Physarum compressum* were seen on a felled sycamore within a few feet of each other; the two species seem to be frequently associated. *Didymium melanospermum* occurred, as usual, on coniferous wood; *Physarum sinuosum* and *Diderma hemisphericum* were also found. On Friday, September 13th, search was made in Staynor Wood. Here oak was the prevalent tree, with some undergrowth of bramble and much of bracken, neither of which yielded Mycetozoa in any abundance. On some old yew stumps were found three species of *Cribraria*, a genus usually frequenting coniferous wood. The species were *C. rufa*, *C. aurantiaca* and *C. intricata*; the last is common in the tropics and in the United States of America, but rare in Britain; it does not appear to have been recorded before from Yorkshire. In a stretch of swampy ground, under sycamores, the dead leaves and lower parts of stems of yellow iris and gipsywort were adorned with a magnificent growth of *Diachaea leucopoda*, extending intermittently over an area of about forty-eight square yards. In the same swamp a specimen of the elegant var. *tenerrima* of *Comatricha pulchella* was found.

The following list gives the species recorded during the whole foray. *O.* stands for Osgoodby Woods, *C.* for Camblesforth, *B.* for Bishop's Wood, *By.* for Byram Park, *E.* for Escrick, *P.* for Parlington, and *S.* for Staynor Wood.

Ceratiomyxa fruticulosa (Muell.) Macbr., *O., C., By.*
Badhamia panicea (Fr.) Rost., *B., P.*
B. utricularis (Bull.) Berk., *C., P.*
Physarum nutans Pers. Found daily.
P. viride (Bull.) Pers., *By., P., S.*
P. psittacinum Ditm., *P.*
P. compressum Alb. & Schw., *P.*
P. sinuosum (Bull.) Weinm., *P.*
P. cinereum Pers., *B., P.*
Fuligo septica (L.) Gmel. *O., By.*
Leocarpus fragilis (Dicks.) Rost., *O., E., S.*
Craterium aureum (Schum.) Rost., *By.*
C. minutum (Leers) Fries., *C., By., P., S.*
Diderma effusum (Schw.) Morg., *By.*
D. hemisphericum (Bull.) Hornem., *P.*
Diachaea leucopoda (Bull.) Rost., *S.*
Didymium difforme (Pers.) Duby, *O., C., P., S.*
D. Clavus (Alb. & Schw.) Fr., *By.*
D. nigripes Fr., *By.*
D. melanospermum (Pers.) Macbr., *P.*, var. *minus* Lister, *P.*
D. squamulosum (Alb. & Schw.) Fr., *O., C., By., E.*
Colloderma oculatum (Lipp.) G. Lister, *E.*
Stemonitis fusca Roth., *O., P., S.*, var. *confluens* List., *By.*
S. flavogenita Jahn., *By., P.*
Comatricha nigra (Pers.) Schroet. Found daily.
C. pulchella (Ch. Bab.) Rost., var. *tenerrima* Lister, *S.*
C. typhoides (Bull.) Rost., *C., E.*
Lamproderma scintillans (Berk. & Br.) Morg., *By.*
Enerthenema papillatum (Pers.) Rost., *P.*
Cribraria rufa (Roth.) Rost., *S.*
C. aurantiaca Schrad., *S.*
C. intricata Schrad., *S.*
Dictydium cancellatum (Batsch) Macbr., *By., P.*
Dictydiaethalium plumbeum (Schum.) Rost., *By., P.*
Reticularia Lycoperdon Bull., *C., P.*
Lycogala flavofuscum (Ehr.) Rost., *By.*
L. epidendrum (L.) Fr., *C., By., P.*
Trichia persimilis Karst., *C., P.*
T. scabra Rost., *P.*
T. varia Pers., *O., C., By., P.*
T. contorta (Ditm.) Rost., *By.*
T. decipiens (Pers.) Macbr., *By., P.*
T. Botrytis Pers., *C., P.*
Hemitrichia Vesparium (Batsch) Macbr., *O.*
Arcyria ferruginea Saut., *O.*
A. denudata (L.) Sheldon, *By., P., S.*

A. incarnata Pers., *By.*, *P.*, *S.*
A. cinerea (Bull.) Pers., *By.*, *E.*, *P.*, *S.*
A. pomiformis (Leers) Rost., *C.*, *P.*, *S.*
A. nutans (Bull.) Grev., *C.*, *By.*, *E.*, *P.*, *S.*
Perichaena corticalis (Batsch) Fr., *P.*
P. depressa (Lib.) Rost., *By.*, *P.*

This makes a total of fifty-two species, and is the second largest list of Mycetozoa recorded on our forays. The wonderful Forres visit in 1912 yielded eighty-one species, that of Swansea, in 1915, forty-seven species; Shrewsbury in 1916 and Wrexham in 1910 each gave us forty-four species; Haslemere, in 1913, forty-two species; and Doncaster, in 1914, thirty-six species.

PRESIDENTIAL ADDRESS.

By the Very Rev. David Paul, LL.D., D.D.

ON THE EARLIER STUDY OF FUNGI IN BRITAIN.

It was natural that, among those who in ancient times began to observe the vegetable world, and to unite its individual productions into groups, attention should have first been directed to the Flowering Plants. The striking beauty of so many of them, their wonderful diversity in form and colour and fragrance, and the manifold ways in which they could be made use of for the advantage of man, early arrested the eye, and stimulated curiosity, and led to their closer study. But Fungi had a hard fight to be included in the awakened interest in trees and shrubs and herbs, and it is only in comparatively recent times that they have won their way to adequate recognition. No doubt Theophrastus, three hundred years before Christ, wrote a History of Plants which is still extant, in which he makes many references to these lower and less conspicuous plants, and a hundred years later Dioscorides compiled a Treatise on *Materia Medica* which was for many centuries received as a standard authority, and in which Fungi are not overlooked. Then soon after the middle of the first century of our era Pliny the Elder wrote his *Historia Naturalis*. It is

in no sense a scientific work, and it is not even the work of an original observer; Pliny was only a man of astonishing industry who collected his material from all available sources, and set it down in very confused form. We have to thank him, however, for his diligence in gathering together a storehouse of information on the ancient world and its knowledge of plants, which otherwise we should have known nothing of. These earliest writers while they mention various Fungi seem to regard them as being so well known as to require no exact description, and it is, except in a few cases, impossible to identify them satisfactorily. They looked at them almost entirely from the gastronomic point of view, and the true study of Fungi cannot be said to have then begun. They did not contribute any helpful suggestions to the earliest observers of fungi in Britain.

Many centuries elapsed before even the roughest foundation of the science of Mycology was laid. All through the Middle Ages plants were studied mainly for their supposed curative properties, and Fungi do not appear to have found a place in the curious prescriptions of the old leeches. It was not till the sixteenth century that they began to be included among plants, or to be dealt with either in this country or abroad alongside of the observed and described Phanerogams. At the opening of that century no book on Botany had been published in Britain, but during its course at least four passed through the press, none of them of much use for our purpose, but all of them of great interest as illustrative of the manner in which what is now a great science was born, and nursed in its infancy. The development of that science is a vast subject, and I propose only to sketch to-night the steps by which our knowledge of Mycology was gradually advanced by our earlier writers.

In 1516 the first edition of the *Greate Herball* was published, no author's name being attached to it. It is a very curious book in black letter and is the earliest British book on Plants. It deals mainly with their medicinal qualities, and gives practically no descriptions. To turn over its pages and read here and there affords a good idea of the position of plant study before it had been rescued from the childishness of the Middle Ages. The writer evidently draws largely on still earlier books of the same kind published on the Continent. There is one short chapter on Fungi, the only one that we need notice, and it will illustrate the character of the book if I quote the quaint remarks the author makes on them:

"Fungi ben muscherons. They be cold and moyst in y^{e} third degre and that is shewed by theyr vyolent moysture. There be twoo maners of them, one maner is deadly and sleeth them that eateth of thē, and be called tode stools, and the other

doeth not. They that be not deadly have a gross gleymy moystur, that is disobedient to nature and digestion, and be perillous and dredful to eate, and therefore it is good to eschewe them, such as eate them and fear not to fall inconvenience, seeth them in water and medle them with gynger, peper, caruy, calamint, or orygan and such other, and then drinke olde wyne, pure and stronge. And they that be of olde complexion, after thē take grene gynger, dyaterion, pyperion, solergenne and tryacle. The deadly muscherons ben of diuers actions after their diversitie and sleeth by their exceeding great cold and moysture y^e^ is in the fourth degre. Some slee by the evell quality of the place that they grow in as by rusty yron, rotten cloth or wood or nigh the hole that serpēts brede in, or thei that grow by great trees that have glewmy humours and frothe. The signs of them that be deadly is a slymye softenesse as they were puffed and be of thick substaunce, and if they lye a whyle broken they will rotte."

I have given this at length as shewing the style of the book, and as being the first notice of Fungi I have met with in the English language. Evidently the writer has in view only the larger and gilled Fungi, and just as clearly he has not even a rudimentary knowledge of them.

Passing from that book, the next that claims attention is *The Herbal of Wm. Turner*, Doctor in Phisick, as he is called on the title page, which was first published in 1551, and afterwards in an enlarged edition in 1568. This shews a great advance on the *Greate Herball*, and if one were dealing with flowering plants it would be necessary to consider it at some length, but it contains no notices of Fungi. Among the many woodcuts are some of ferns which are not separated from flowering plants. Turner was a theologian and a church dignitary, a scholar and a Reformer, who wrote much on religious questions, but he is now known only as a botanist who was an original observer, and who had shaken himself clear of most of the medieval fancies. It would have been interesting to know what were the views on Fungi of this "first of English botanists," as he is deservedly called.

A very important work was published in 1597, the well-known *Gerard's Herball*. However interesting it may be from a general botanical point of view, the day of Fungi had not yet arrived. Gerard does not indeed omit Fungi altogether, for he devotes one chapter to them. He calls them "bastard plants" and speaks of them as "earthy excrescences called mushrumes or toadstooles, whereof some are very venomous and full of poison, others not so noisome, and neither of them very wholesome meate; wherefore for the avoiding of the

venomous quality of the one, and that the other which is lesse venomous may be discerned from it, I haue thought good to set forth their figures, their names, and places of growth." There is no attempt at classification except that they are divided into edible and non-edible, but there are fairly good woodcuts of seventeen species including the Fly mushroom, a *Clavaria*, apparently *aurea*, Jew's ear, *Clathrus cancellatus*, Morel, Stinkhorn, and a kind of Tuber. It may be noted that the Morel is put among the non-edible Fungi, and that the figure of *Clathrus* was taken, as well as almost all the others, from the *Icones* of Tabernaemontanus, published in 1590.

Another well-known Herbal was published in 1640 by John Parkinson under the title of *Theatrum Botanicum*. He calls himself "Pharmacopaeus and King's Botanist." Among the 4000 plants which he attempts to describe are 64 Fungi—32 wholesome and 32 dangerous. His figures are mostly the same as Gerard's, figures that did duty in other botanical books of the period, the blocks having been brought from the Continent. His classification and descriptions shew no improvement on those of Gerard.

Parkinson was the last of the Herbalists. Their notions of the nature and affinity of plants were of the crudest. Anything that could be called a system of classification was unknown to them. They still burned incense religiously to Theophrastus and Dioscorides, whose authority they would regard it as little short of blasphemy to question, and whose wildest flights of fancy they quote with evident approval. One looks through their huge tomes with admiration of their industry and zeal, but with amazement at their naïve simplicity and lack of a scientific spirit. Their merit lies in their collection of so many plants, however disorderly it may be, and in their illustrative woodcuts. Fungi have naturally suffered most at their hands, even those that required no microscope for their observation. In justice to them we must remember that they had no books to refer to which could throw light upon the subject. They were dealing with the very beginnings of a difficult branch of Botany, and little could be expected of them.

Taking leave of these, we pass into the next century to notice a work which marks an epoch in British Botany—the *Synopsis methodica stirpium Britannicarum* of John Ray, first published in 1690 and third edition in 1724, after his death. Ray, the son of an Essex blacksmith, went to Cambridge and afterwards took Holy Orders. Two of his sermons were famous in their day. At College he lectured on Greek, Mathematics and Latin successively. Leaving it in 1662 he gave himself entirely to his favourite study of plants, travelling in search of them

through the greater part of Britain, as well as the Low Countries, Germany, Italy and France, and embodying his researches in his great work, *Historia Generalis Plantarum*, first issued in 1686. It was impossible for a man of his acute mind to neglect Fungi, though he threw his strength into the Phanerogams. In his *Synopsis methodica* we find the first classification of them in the English language which is of any interest. He divides them into five classes:

I.—Fungi with both pileus and gills—of which he describes 57 including *Lactarii* and *Cantharellus*.

II.—Fungi with a pileus but no gills, such as the *Boleti* and *Phallus*—17 described.

III.—Fungi without a pileus. Twenty-two species of these are described, and he divides them into three groups. The first group he calls *Fungoides*, and defines the term as a fungus without a pileus, whose stems are variously shaped and divided but whose substance is uniform and is destitute of gills or pores. As examples *Xylaria polymorpha* and *X. hypoxylon* are given. The second group under this head is *Pezizae*, of which he gives 22, including among them the Jew's ear. The third group is *Agaricus*, a term used by him in its old sense, and defined by him as a "fungus which has neither pileus nor stem, and generally grows laterally and horizontally on trees, sometimes smooth beneath, but for the most part with the under surface divided into gills or pores." Of these he describes 28, and among them what he calls *Agaricus intybaceus* and *A. igniarius*. He would include, in addition to the stemless *Polypori*, such Fungi as *Pleurotus*, *Crepidotus*, etc.

IV.—Fungi pulverulenti. "Puff-balls; dusty mushrooms; Bull-fists." He describes 13, including *Lycoperdon giganteum* and *Geaster*.

V.—Fungi subterranei. All underground Fungi, e.g. Truffles.

It will be noted that, however imperfect, this is still a classification. It is a groping after an orderly arrangement, and is distinctly superior to anything we have yet met with. Ray had evidently been giving Fungi considerable attention, for in each successive work of his there is an advance. In his *Catalogus Plantarum* (1677) about 25 Fungi are given but without any order or classification at all. In his *Historia Plantarum* (1686) he divides them into four classes: (1) Terrestrial Fungi, with pileus and gills, which are subdivided into the old groups of edible and noxious; (2) Terrestrial Fungi without gills, but having a more or less distinct pileus; (3) Fungi of every kind that grow on trees; (4) Underground Fungi. This is a much poorer classification than that of the *Synopsis* which has been already given. In it the foolish distinction between edible

and poisonous, which had obsessed all previous British authors, is dropped, as also his class of tree-fungi, and his final classification shews scientific progress in his ideas. Ray, as well as Turner, has been called the "first British Botanist," and even in regard to Fungi that honourable title is deserved. His *Synopsis* was for long the standard English Flora.

After the death of John Ray at the beginning of the eighteenth century the first name which claims attention in connection with the study of Mycology is that of William Hudson (1732–1793). He was a Fellow of the Royal Society and Director of the Botanic Garden at Chelsea. His reputation rests on his *Flora Anglica* of which the first edition was published in 1762. By this time the writings of Linnaeus had become known in England, particularly after his visit to this country in 1732, and his system of classification became the subject of much criticism and controversy. Hudson was one of his principal champions, and his *Flora* was the first of any importance to be arranged according to the principles of the great Swedish botanist. With its general merits we are not concerned here further than to note that it was received with acclamation, and superseded as the chief English text-book Ray's *Synopsis*, which had held that position for seventy years. It is interesting to us now from the fact that he dealt as fully with Cryptogams as was possible at the time, describing Ferns, Mosses, Algae and Fungi. He adopts with great advantage the binomial nomenclature of Linnaeus. His indebtedness to Ray's *Synopsis*, as well as to Bauhin's *Pinax*, is freely acknowledged. The method he adopts is, first to give the description of Linnaeus from his *Species Plantarum*, then those of Bauhin and Ray when available; to this he adds an English name and the habitat. His meagre list is divided into nine genera: *Agaricus*, *Boletus*, *Hydnum*, *Phallus*, *Elvella*, *Peziza*, *Clavaria*, *Lycoperdon* and *Mucor*. And the curious thing is that instead of adding to the number of Ray's plants he does not describe nearly so many. Ray gives 57 gilled Fungi, while Hudson has only 24; of his order *Boleti* (including *Polypori*) Ray gives 17 and Hudson 9, and so on. No doubt in the second edition of the *Flora Anglica* published in 1778, the number of *Agarici* has mounted from 24 to 51, and the number of *Boleti* from 9 to 13, but as the *Agarici* included all gilled Fungi and the *Boleti* included all Fungi with pores, it is evident that a very large number of quite common plants in both genera were overlooked by him. In his second edition he adds a genus *Clathrus*, containing eight *Mycetozoa*. It is not however worth while to examine this *Flora* further. Hudson had given little time or attention to Fungi, and he did not know more than a very few. He had

too much on hand in trying to deal with phanerogams and cryptogams together. In his preface he frankly acknowledges that in the field of Fungi he was greatly deficient, and that taught by experience he could repeat the words of Linnaeus that the whole subject was still in chaotic confusion. It was impossible for any one in his day seeking a knowledge of Fungi to obtain help from his book.

From Hudson let us pass to Relhan whose *Flora Cantabrigiensis* was published in 1785, twenty-three years after the *Flora Anglica*. Like so many of the botanists of that century and the preceding, Richard Relhan was a clergyman, and he became a Fellow of King's College, Cambridge. In his first edition he follows closely on the footsteps of Hudson, but adds a separate class of *Sphaeria*, composed of Xylarias and Hypoxylons with one *Nectria*. His second edition however which was published in 1820, contains several features which mark an advance in classification. Under the influence of Withering he attempts to break up the genus *Agaricus*, in which were still included all gilled Fungi. He first splits it up into three groups of stalked, slightly stalked, and stemless, dividing these again according to the attachment and colour of the gills. He adopts a genus *Merulius*, which is not found in his first edition, containing five *Marasmii*, two *Cantharelli*, and a *Craterellus*. The number of his *Agarici* is increased from 35 to 96, his *Boleti* from 7 to 22, and so on. Another genus added is *Auricularia* of Bulliard, embracing three *Stereums*, one *Corticium*, a *Thelephora* and a *Merulius*. He did not altogether overlook the minute Fungi, but includes *Sphaeria*, *Stemonitis*, *Trichium*, *Aecidium*, etc., giving two or three of each. His second edition of the *Flora Cantabrigiensis* is thus an advance on his first edition, and of much greater value to students, but his descriptions are too short for satisfactory identification. This defect is partially counterbalanced by his constant references to the figures of Sowerby, Bulliard and Bolton.

The *Flora Scotica* of Lightfoot appeared in 1777, and passed into a second edition in 1792. It is of much interest, especially to Scotsmen, so far as phanerogams are concerned, but it contains nothing noteworthy in regard to Fungi, only 67 species being referred to.

John Sibthorp, Professor of Botany at Oxford, published in 1794 his *Flora Oxoniensis*, but that too as a contribution to Mycology was of no particular importance.

Then, in 1788, there appeared Bolton's *Historia Fungorum circa Halifax sponte nascentium*, which is valuable for its well-known illustrations, but is mentioned here that a passage from

its preface may be quoted. "The plants," he says, "which now compose the order Fungi were formerly supposed to be of equivocal generation, the sport of nature, the effect of putrefaction or the brood of chance, but that they owe their original to the seeds of a parent plant is now well known, having been proved by, *inter alios*, the ingenious Hedwig, who in a work entitled *Historia generationis et fructificationis Plantarum Cryptogamicarum*, published in quarto at Petropolis in 1784, has by means of the microscope proved beyond dispute the existence of stamen and style, or of male and female organs. in these, as perfect and regular and effective in the production of proper seeds as in any other vegetable where they are more obvious to the sight." The passage is of interest, not as being a correct statement of the method of the reproduction of fungi, but as an attempt to dissipate the crude ideas that formerly prevailed, and to provide a definite place for fungi within the vegetable kingdom.

The popular interest in Botany which was growing in the last half of the eighteenth century is evidenced by the number of Floras that it produced. Hill's *Flora Britannica* appeared in 1760, Hudson's *Flora Anglica* in 1762, Martyn's *Plantae Cantabrigienses* in 1763, Withering's *Botanical Arrangement* in 1776, Lightfoot's *Flora Scotica* in 1777, Relhan's *Flora Cantabrigiensis* in 1785, Sibthorp's *Flora Oxoniensis* in 1794, Dickson's *Catalogus* in 1795, and Hull's *British Flora* in 1799. It was the era of Floras. No doubt interest mainly centred in Flowering Plants, but it was gradually spreading to Cryptogams also. Of these Fungi were the last to be brought into the current, and the progress in the century, since Ray's *Synopsis* appeared in 1690, was not all that might have been expected, even in the case of the larger Fungi that can be examined with such ordinary lenses as were then in use. To deal in detail with all these Floras would occupy much time, and is unnecessary for our purpose, but the appearance of Withering's *Arrangement of British Plants* is worth a short notice. It is a work for which I have an affection, as it is the only botanical book I had access to when I was a boy.

Withering was born in 1741 at Wellington and was educated at the University of Edinburgh, where he took the degree of M.D. in 1766, afterwards practising at Stafford and at Birmingham. In 1776 he published his *Arrangement of British Plants* which reached its third edition in 1796, three years before his death. It is in four volumes, the last volume being devoted to cryptogamic plants. He was not a distinguished botanist, and he seems to have taken little or no share in the discussion of the plant problems that then occupied the attention

of his botanical brethren. His merit lies in the fact that he was an able and industrious field-botanist whose labours went far to increase the knowledge of plants in this country. Both Sir James E. Smith and Sowerby held his work in high esteem. He had the good sense to write his Flora in English whereas Hudson, Relhan and their predecessors had used Latin. In the Fungus part of his book the descriptions and notes are fuller and clearer, so that it is always possible to identify the plant he is dealing with. His division of the gilled Fungi too is more elaborate and he passed a much larger number under review. Evidently he had examined them carefully for himself. His subdivisions rest on the nature of the stem, whether solid or hollow, whether central or lateral or wanting, on the colour of the gills, and their mode of attachment. This is so far a convenient grouping, but it is not natural; it does not take account of volva or ring or the character of the veil or the substance of the flesh. Consequently utterly different groups of gilled Fungi, such as *Agarici* proper, *Cortinarii, Hygrophori, Marasmii, Lactarii,* are found side by side. At the same time it was the most complete division of the vast order of *Agaracini* that had yet been proposed. In principle it is the same as that of Hudson but it is more fully elaborated. His division of the *Boleti,* including the *Polypori,* is similar—pored Fungi with stem central or lateral or wanting, and with pores white, brown, buff, etc. His remaining genera are similar to Hudson's—*Hydnum, Helvella, Auricularia, Peziza, Nidularia, Phallus, Clavaria, Tuber, Lycoperdon, Reticularia, Sphaeria, Trichia, Mucor.* Though a great field of Mycology was not traversed either by him or by any of his predecessors, partly because of the inferiority of their microscopes, and partly because so much work among the less minute Fungi had still to be performed, yet the knowledge of Fungi was increasing yearly, as is plain from the fact that Relhan's 96 gilled Fungi had mounted up in Withering's Flora to no fewer than 280. The true principles of classification, however, had not as yet been grasped. Nevertheless, those British students of Fungi of the eighteenth century, whose works we have been able only to glance at, beginning with John Ray, author of the *Synopsis Methodica,* ought not to be forgotten, or their work undervalued. They prepared the way for fuller light to be shed on a difficult subject, and perhaps none of them is more worthy of recognition than Withering, who has not, I think, received all the credit that he deserves.

For the first quarter of the nineteenth century there is not much of moment to notice. Sowerby's admirable figures of Fungi were published between 1797 and 1803, and Greville's *Scottish Cryptogamic Flora* between 1823 and 1828. The

plates in both these works have not been surpassed, and they were of first-class importance at the time for the study of fungi, and indeed are so still. It was only however in the second quarter of the century that any forward movement was made in this country in the study of Fungi, that which will always be associated with the name of Berkeley. Before touching briefly on his great contribution to Mycology, it is necessary to mention the name of one to whom he was much indebted, Elias Fries of Sweden. I have not hitherto taken notice of the work of foreign botanists or of their influence on our own countrymen as that would have led into too vast a field, but Fries stands by himself in the department of Mycology and his influence on all his contemporaries and successors has been too marked to be left unmentioned.

His first important work on Fungi, the *Systema mycologicum*, was published between 1821 and 1832; his *Epicrisis* in 1838; his *Monographia* between 1857 and 1863, and his *Hymenomycetes Europaei* in 1874. How he prepared himself for these works he tells us himself. He describes his wanderings through every accessible part of Sweden, his untiring industry in observing and collecting specimens, the unflagging enthusiasm with which he pursued the study of Fungi from the time that as a boy of twelve he accompanied his mother into a wood to gather strawberries, and there found a very large specimen of *Hydnum corralloides*, his passion for accuracy shewn in his examination and description, three times repeated, of all the species he could discover, and his determination to make his different lists as complete and perfect as he possibly could. That spirit in which he worked for more than sixty years lay at the root of his success, and prepared the way for the high position he received among European mycologists. He developed a genius for classification and for detecting affinities, and among the *Hymenomycetes* in particular his grouping of the plants has hardly been improved on. Perhaps our love of Fries and our obligations to him cause us to exaggerate his merits, but after all allowance has been made for the devotion of pupil to master, and the warping of judgment that may arise from it, the study of earlier works on Mycology in our own country makes it perfectly clear that he stood head and shoulders above all our authors in that branch of Botany. We are not on that account to minimise what those earlier authors have done; they were groping their way among difficulties, dealing with plants presenting great perplexities, and gradually working out a scientific system. Each of the early students of Mycology made his contribution, and, as they succeeded one another, each enjoyed the benefit of his predecessors' attempts and failures.

It could not have been otherwise, and Fries would have been the first to acknowledge his indebtedness to those who went before him. These considerations must not however blind us to the fact that in botanical classification and description he occupies a foremost place. It is mainly due to him that Mycology has so many ardent students in this country as it has to-day.

Let us pass now to Berkeley. Like so many other British Mycologists he was a clergyman, and performed the duties of two country charges in succession while he was carrying on his scientific work. His eminence as a Mycologist is well known. As far back as 1836 his reputation in that branch of Botany was so well established that Sir William Hooker entrusted him with the preparation of the volume on Fungi which completed Sir James E. Smith's *English Flora*. Elias Fries held him in the highest estimation, and regarded him as the man qualified above all others to draw up a synopsis of the Extra-European *Hymenomycetes*. As regards British Fungi he has been styled the virtual founder of our Mycology. He possessed Fries' enthusiasm, his accuracy, his power of patient observation, his wide outlook over the field of Botany, and his instinct in the detection of affinities and differences. During a long life he maintained his high place in Botany. No doubt he was a Taxonomist much more than a Morphologist, but that was in the natural order of things. Classification of plants must precede the minute investigation of their structure, and the first claim which Fungi made on a botanist in the third decade of last century was classification. We have dealt with some of the attempts to arrange the larger fungi that had already been made; let us look at Berkeley's contribution.

The first volume of Fries' *Systema Mycologicum* appeared in 1821, fifteen years before Berkeley's volume on Fungi contained in Smith's *English Flora*. It embraced the *Hymenomycetes*. On comparing the classification of these in the two books we find that they are practically the same; Berkeley simply adopted Fries' classification. Subsequently Fries improved that arrangement, adding two new genera, *Hygrophorus* and *Marasmius*, whose members had previously been included in one or other of the subgenera of *Agaricus*, and Berkeley in his "Outlines" adopted that improvement, as well as the addition of the genus *Lentinus*. There is no originality then in Berkeley's work so far as the classification of these higher Fungi is concerned. His merit as a British Mycologist lies in this, that he immediately recognised the value of Fries' divisions, and adopted them for the benefit of science in his own country. It is not indeed a perfect classification, for it is partly natural

and partly artificial. The large genus *Agaricus* had to be broken up in some way or other, as otherwise it was unmanageable, and Fries accordingly split it into what he calls *series*, determined by the colour of the spores. One had then manageable groups to deal with, but they are artificial groups, for the colour of the spores is not a sufficient basis to rest them on, and has the effect of keeping fungi far apart whose affinities are very close. It is no doubt a convenient arrangement, and as such it has held its ground. Within the series of groups, however, the arrangement is strictly natural, one might say beautifully natural, drawing together into corresponding subgenera the plants that have the closest affinity. Even in regard to the employment of spore-colour as a prime feature in the classification of *Agaricus*, there is this to be said in its favour that it is a great improvement on the use of gill-colour for the same object, as the colour of the spores is fairly constant and unchangeable, which the colour of the gills is far from being, and it is strange that the earlier mycologists did not take account of the colour of the spores at all. That Berkeley should have adopted and popularised in this country the classification of Fries is one of his chief merits.

He has, however, merit of another kind. He is, I think, unsurpassed in his description of species, and this is best seen in the fifth volume of Smith's *British Flora*. Fries' descriptions of species in the *Monographia Hymenomycetum* are very fine, but Berkeley's are as careful and minute, and appeared long before that work of Fries was published. The early descriptions of Fungi were so imperfect that it is often impossible to identify the plant described. One has only to compare the descriptions of the same species in the *Pinax* of Caspar Bauhin and in Ray's *Synopsis* and Hudson's *Flora Anglica* with those of Berkeley in Smith's *Flora* to appreciate the great advance that had been made. In plants like fungi ample descriptions are of special value, as both Fries and Berkeley recognised, if a species is to be certainly determined, and they both set themselves to provide such descriptions drawn up by themselves after comparison of many individual specimens. That is one of the debts we owe to them both, to Berkeley at least as much as to Fries.

Berkeley's merit and reputation rest on more than his identification, description and classification of species, though it may perhaps be said that in connection with that his best work was done. I have purposely laid stress on that part of his work, because in that field he was carrying on and perfecting what the earlier writers on fungi had for two centuries been giving their attention to. In dealing with the early study of

fungi in this country his name need not perhaps have been mentioned at all, and he might have been properly regarded as the inaugurator of the newer era of Mycology. But in that case the story of earlier progress would not have been rounded off, and the contrast between the earlier and later results of the study of the subject would not have appeared. When we compare him with those who went before him, we must set his work parallel with theirs, and mark how far he surpassed them on their own lines, as in the number of species he added to the British Fungus Flora and in the admirable way in which he dealt with the already recognised species both in description and classification. I have not sought to characterise his work among the lower minute fungi, because that is outside the field of the earlier study, nor to estimate the value of his *Introduction to Cryptogamic Botany*, published in 1857, in which he treated the relations to one another of the different Families of Cryptogams, though it is a work of the highest merit, and was the first comprehensive work on the subject ever produced, nor have I done more than allude to his unrivalled knowledge of exotic fungi, though it was unequalled in his day, and is witnessed to by the fact that Sir W. J. Hooker entrusted him with the description and classification of all the fungi sent to Kew from abroad, and notably with those collected by Darwin during the voyage of the *Beagle*. It does not enter into the scope of this paper to deal with Berkeley's varied and valuable contributions to British Mycology generally, it only falls within its range to contrast the results of his study of the larger and more conspicuous fungi with those of his predecessors, regarding him as being, at least in the first part of his life, the last of the earlier students of the science.

We have thus travelled down the road of mycological study, from the dark age of the Herbals when classification was practically non-existent, and when corals and sponges were included among Fungi, onwards through successive gropings after a systematic arrangement, and through gradually increasing knowledge of the plants themselves, down to the time when Berkeley in his first published work of importance, but especially in his "Outlines," settled for British mycologists the system of classification of the higher Fungi which still, after the lapse of fifty-eight years, with slight alteration holds the field. I would end with the words of the great Swede in his preface to his *Monographia Hymenomycetum*: "To botanists who live in the country I commend the study of these fungi as a perennial fountain of pleasure and of admiration of the Wisdom which directs the whole of nature."

NOTES ON SOME SAPROPHYTIC SPECIES OF FUNGI, ASSOCIATED WITH DISEASED POTATO PLANTS AND TUBERS.

With Plates III and IV.

By G. H. Pethybridge, B.Sc., Ph.D.

During the progress of a series of investigations* on various diseases of the potato plant in Ireland, which have extended over several years, special attention was naturally devoted to the part played by parasitic fungi. In the course of the work, however, a number of saprophytic species associated with the parasites were met with, some of which were previously undescribed or imperfectly known; and a certain amount of attention was devoted to them.

It is proposed, in the following notes, to deal briefly with a few of these saprophytes; and the observations and descriptions which follow are based, to a large extent, on the characters and behaviour of the various species, when grown in pure culture, a single conidium or spore having been made the starting-point of the culture in each case. The study of micro-fungi in pure cultures offers many advantages, and had this method been available to and employed by earlier workers in mycology, many mistakes would have been avoided. It is clear, for reasons which need not be discussed here, that whenever possible this method should be adopted by workers in future.

I. NECTRIA INVENTA.

(Syn. *Verticillium cinnabarinum* Reinke et Berth.)

The more or less ubiquitous fungus *Acrostalagmus cinnabarinus* Corda† was, in 1879, re-named *Verticillium cinnabarinum* by Reinke and Berthold‡, who pointed out that Corda's generic name was founded upon an error of observation as to the manner in which conidia were produced. Nevertheless both Saccardo§ and Lindau‖ retain Corda's original name.

* Reports on these investigations will be found in the Journal of the Department of Agriculture and Technical Instruction for Ireland, x.–xviii. 1910–1918.

† Icon. Fung. ii. p. 15, 1838.

‡ Zersetz. d. Kartoff. p. 63, 1879.

§ Syll. iv. p. 163, 1886.

‖ Rabenh. Krypt. Fl. i. 8, p. 339, 1904.

This fungus is found quite frequently on the surfaces of decayed potato tubers in its well-known red conidial stage. It was grown in pure culture for a period of fifteen months on various nutrient media in the hope that some other form of fructification might develop in one or other of them. This, however, did not occur.

In July 1915 a number of old, diseased "seed" potatoes that had been thrown into a wet ditch in the spring were examined, more or less as a matter of curiosity. On the surfaces of several of these tubers a number of perithecia were found. A few of the latter were almost black; and microscopical examination showed that they probably belonged to some species of Gibberella. Most of the perithecia, however, were dark red in colour, somewhat similar to those of *Hypomyces Solani* R. et B. Since, however, a stroma was present it was evident that they belonged not to the genus Hypomyces, but to Nectria. Comparison with type material of *N. Solani* R. et B. showed that they were certainly not that species*.

Closely associated with the red perithecia was a copious development of the conidial stage of *V. cinnabarinum*, so close, in fact, that in some cases conidiophores of this fungus were present on the stroma, and even on the surfaces of the perithecia themselves. The question arose, therefore, as to whether this was a case of mere association, or whether the perithecia actually belonged to *V. cinnabarinum*. Many of the perithecia were still unripe, but in others ripe ascospores were present, and trials made in hanging-drops showed that the spores were viable.

Careful and continuous microscopic observations were made in five separate instances on the development of isolated individual ascospores in film cultures on the undersides of coverglasses, this being a more advantageous method of study than the hanging-drop. In each case the spore germinated and produced mycelium, which soon gave rise to conidiophores and conidia exactly similar to those of *V. cinnabarinum*, the growth from the original ascospore to the development of conidiophores and conidia being traced in unbroken sequence.

In another case the course of development from ascospore to conidia-production was followed under the microscope with a culture on a thin film of nutrient medium in a Petri dish. This is illustrated in Fig. 3, Plate III. The two-celled ascospore

* *N. Solani* does not appear to be a common species. I have never come across it and there is no reliable record of its occurrence in the British Isles. For years, however, in English phytopathological literature this fungus was credited, quite erroneously, with being the cause of the dry-rot of the potato tuber.

(*a*) is still discernible in the middle of the growth on the right, while on the left the young conidiophore borne on the hypha (*h, h*) is shown. Although this hypha is drawn in the figure with partially discontinuous walls, it was, as a matter of fact, continuous. The figure was drawn with the aid of a camera lucida which did not permit of the whole growth being outlined in one single field of view.

A stock pure culture was raised from a single ascospore, and this was made the basis of a series of sub-cultures on seven different media. A stock pure culture of *V. cinnabarinum* was raised from a single conidium of the fungus growing on a decayed potato, and sub-cultures from it were made on the same media. No differences, either macro- or micro-scopic, were discernible in the growths developed in the series of parallel cultures. Hence it is concluded that the perithecia, originally found on the surfaces of the rotting tubers in very intimate association with the conidial stage of *V. cinnabarinum,* are indeed the perfect state of fructification of this fungus*. This species, therefore, must be removed from the Fungi Imperfecti and be placed amongst the Ascomycetes.

The ripe perithecia are spherical or globular in shape and possess an ostiole, but are scarcely papillate. They are "cameo-brown"† in colour and bear short, stiff multi-cellular hairs or appendages on their upper halves. A stroma is present which in some cases bears only one perithecium, and in others more than one. The wall of the perithecium is several cells in thickness and more or less leathery, or cartilaginous in substance, not brittle. Long paraphyses are present in young perithecia, at any rate, but they are not easily made out and they disappear later on. They are more easily seen in the carefully teased out contents of a perithecium which is not too ripe than in sections. The asci are typically eight-spored but a lesser number sometimes occurs. The ascospores are arranged in one row and are 1-septate when ripe, single-celled when young. The walls of the paraphyses and asci appear to become mucilaginous, so that a fully ripe perithecium contains a mass of isolated ascospores embedded in a more or less gelatinous matrix. Fig. 4, Plate III, represents a longitudinal section (not quite a median one and slightly diagrammatic) through a perithecium and its stroma. The asci

* After this pure culture work was completed a case was met with in which one of the actual appendages of a perithecium had developed a conidiophore of *V. cinnabarinum* as a lateral branch, proceeding from near its distal end. This affords yet another link in the chain of proof that the fungus producing the perithecia is *V. cinnabarinum.*

† Ridgway, R. Color Standards and Color Nomenclature. Washington, D. C., 1912. Plate 28. 7″ k.

and the paraphyses are shown in more detail in Fig. 5, while Fig. 1 illustrates ripe and unripe ascospores and Fig. 2 shows ascospores germinating.

As regards nomenclature, the combination *Nectria cinnabarina* cannot, of course, be adopted, since this name is already in use for the well-known "Coral Spot" fungus. Since the perithecia were discovered more or less by accident the specific name *inventa* does not seem inappropriate. The characters of the fungus may be summed up, as follows:

NECTRIA INVENTA Pethybridge.

Peritheciis gregariis, globosis, atro-rufis, superiore parte pilosis, 300–500μ diam., paraphysibus filiformibus dein obsoletis, 3–4μ × 150μ; ascis cylindricis, vel cylindraceo-clavatis, 60–100μ × 4–6μ, octosporis; sporidiis monostichis, oblongis, hyalinis, 1-septatis, 4–5μ × 9–10μ.

Hab. In tuberibus putresc. *Solani tuberosi* in Hibernia. Status conid. sistit *Verticillii cinnabarini* R. et B. (*Acrostalagmi cinnabarini* Corda).

Inoculations with pure cultures, through wounds into living potato stems and tubers, did not result in any sort of infection; hence the fungus is a saprophyte, so far as the potato is concerned at any rate. Control inoculations into stalks of healthy growing potato plants were made at the same time with a pure culture of *Verticillium albo-atrum* R. et B. and hadromycosis was set up in each case.

II. COLLETOTRICHUM TABIFICUM.

(Syn. *Rhizoctonia tabifica* Hallier.)

In a paper published in 1875 Hallier* attributed the disease in potatoes known as "Curl" to the presence (chiefly in the pitted vessels of the wood) of a parasitic fungus which he named *Rhizoctonia tabifica*. Of course no cultures of the fungus were made, nor were any infection experiments carried out, and a critical study of the paper leaves no doubt in one's mind but that Hallier was dealing with at least two (if not more) distinct organisms. It is highly probable that the principal one of these was the fungus *Verticillium albo-atrum*, described later by Berthold† and Reinke, investigated more fully by the present author‡ still more recently, and shown to be the cause

* Hallier, E. Die Ursache der Kräuselkrankheit. Zeits. f. Parasitenkunde, iv. 1875, p. 97.

† Loc. cit., p. 67.

‡ Pethybridge, G. H. The Verticillium Disease of the Potato. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), 7, 1916, p. 63.

of a specific disease, hadromycosis, which is one of that congeries of diseases included under the term "Curl" by older writers.

Hallier placed his fungus in the genus Rhizoctonia, because he supposed that it produced certain black, pseudo-parenchymatous bodies (provided with stiff black hairs or setae) which he found on the diseased plants and which he regarded as being sclerotia. There is, however, no proof that these bodies belonged to the fungus luxuriating in the wood vessels, and it is now certain that *V. albo-atrum* produces no such sclerotia.

Bodies corresponding to Hallier's sclerotia were very frequently met with on dead or dying portions of potato stalks, especially on the parts below ground, and often in plants attacked by *V. albo-atrum.* They have not been seen on tubers, although no special search for them there was instituted. They arise beneath the epidermis through which the setae first make their appearance, and one of them in this condition is illustrated in Fig. 6, Plate III. By bursting through, or by the decay of the superficial tissues of the stalk, the whole black body ultimately becomes exposed. The setae are just visible with the naked eye but are somewhat easily broken off on handling the material. Occasionally (when still present) the pith of potato stalks bearing these bodies is of an amethyst tinge.

In some respects these bodies do resemble sclerotia, and they may perhaps function as such temporarily. When young, at any rate, they appear to contain appreciable quantities of oil. But the walls of the hyphae making up the pseudo-parenchymatous tissue are not so thick as one commonly finds in sclerotia.

For some time I was in doubt as to what these bodies really were. Hence, portions of potato stalks bearing large numbers of them were placed in a moist dish, and kept under observation for a considerable time during the summer of 1915. After a while a moist, amethyst-coloured globule arose on the upper surfaces of a number of the black bodies resembling bacterial colonies, but made up, in reality, of masses of conidia. Sections through the bodies showed that they were solid, and that the conidia were produced from a compact surface layer of conidiophores. From this surface the setae also arise; their bases are surrounded by the conidiophores and become submerged in the uprising conidial mass, their tops alone protruding above it.

The structure, as thus revealed, is evidently the fructifying stage of a species of Colletotrichum, and the puzzle as to the nature of what Hallier figured as sclerotia of a Rhizoctonia may now be regarded as solved. A vertical section through

a portion of one of these bodies is illustrated in Fig. 8, Plate III. The ripe spores are easily washed away but four detached ones are shown.

The once or twice septate conidiophores are arranged in a vertical palisade-like fashion and are absent when the "sclerotia" first emerge. They are usually simple, but a few branched ones have been observed. The setae are 1- to 3-septate.

The conidia are elongated, cylindrical, or slightly spindle-shaped, with somewhat bluntly pointed ends. Their size varies, but averages $21\mu \times 3\mu$. They are hyaline and contain either one central vacuole, or two situated towards the ends. They germinate by producing a germ tube from near one end; and after germination many of them, but by no means all, develop a transverse septum and become two-celled. After a few days' growth the mycelium produced gives rise to conidia borne on the ends of short branches and similar to those already described.

From a single conidium a pure culture was raised and sub-cultures were made on several different kinds of media. The mycelium produced is at first hyaline and almost wholly submerged. Old mycelium is smoke-coloured and bears appressoria (see Fig. 7, Plate III). A striking characteristic of all the cultures was the development of a beautiful amethystine fluorescence throughout the medium. After about a week's growth the development of the black bodies (always bearing setae) begins; and they are always produced in a series of concentric zones which are circular in Petri dishes, and oval on slants in test tubes. After a time many of these bodies produce on their surfaces the amethyst-coloured globule of conidia already described. The fungus thus produces conidia directly from the mycelium and also in fructifications of the Colletotrichum type. No other form of fructification appeared in the cultures. Its chief characters may be summarised as follows:

COLLETOTRICHUM TABIFICUM (Hallier pro parte) Pethybridge.

Acervulis gregariis, primo sub-epidermicis, demum erumpentibus, atris, 100–270μ; conidiis continuis, cylindricis vel sub-fusiformibus, hyalinis, multitudine aggregata amethystinis apicibus abrupte aculeatis, $3\mu \times 21\mu$; basidiis fasciculatis, cylindricis, 1–2 septatis, 20–30μ longis; setulis simplicibus, erectis, 1–3 septatis, atris 100–340μ longis; appressoriis atro-fuligineis.

Hab. In stirpibus subterraneis mortuis, vel paene mortuis *Solani tuberosi*, in Hibernia.

Healthy living potato stalks and tubers were inoculated

through wounds with a pure culture of the fungus, but beyond a strictly limited growth at the expense of the cells injured in making the wounds, no development occurred, and no trace of any kind of rot was set up. Since, however, the fungus was found occasionally on stalks not completely dead there may possibly be special conditions under which it behaves as a parasite or at least a feeble parasite.

After the above described study of *C. tabificum* had been made a paper was published by O'Gara* in which a new species of Colletotrichum (*C. solanicolum*) occurring on potato stalks was described. An attempt to obtain a culture of this species failed, but judging from the published description it is just possible that it may be identical with *C. tabificum*.

The setae in the latter appear to be longer and the conidia rather longer and narrower than in *C. solanicolum*, but too much stress must not be laid on these somewhat variable characters. Perhaps the most striking point of difference is that, although O'Gara grew his fungus in pure culture, he does not mention the development in the medium of any amethystine fluorescence such as is so characteristic of *C. tabificum*, and which he would scarcely have failed to observe had it been present. Nor, apparently, was the mass of spores borne by the acervuli of this colour. There appears to be some doubt as to whether *C. solanicolum* is parasitic or not, for no inoculation experiments are reported. But the fungus is stated to have been found on living as well as on dead potato stalks. No amethystine coloration of the pith of affected stalks was noted.

Taubenhaus† has also described a Colletotrichum, derived from potato tubers, which he regards as being identical with *C. solanicolum*. On priority grounds, however, he maintains that it should be called *C. atramentarium* since he regards this fungus as being equivalent to Frank's *Phellomyces sclerotiophorus* and this, in turn, to Berkeley and Broome's *Vermicularia atramentaria*.

Those of us who are familiar with the sterile *P. sclerotiophorus* and its fructifying stage *Spondylocladium atrovirens*, both as it occurs on the potato tuber in Europe and as it behaves in pure culture, will perhaps not readily concur in this view.

In his primary isolation experiment Taubenhaus obtained three fungi from the surface tissue of a potato tuber affected

* O'Gara, P. J. New Species of *Colletotrichum* and *Phoma*. Mycologia, vii. 1915, p. 38.

† Taubenhaus, J. J. A contribution to our knowledge of Silver Scurf (*Spondylocladium atrovirens* Harz) of the white potato. Mem. New York Bot. Gard. vi. 1916, p. 549.

with Silver Scurf, viz. a Colletotrichum, a Fusarium and *Spondylocladium atrovirens*. It seems possible that the sclerotia originally present may have been partly those of Spondylocladium (formerly known as Phellomyces) and partly those of a Colletotrichum. Or, the Colletotrichum may have been present in mycelial form (as also the Fusarium probably was) and was not killed by the preliminary treatment with mercuric chloride. The matter, at any rate, deserves further careful study before the view that Phellomyces is a Colletotrichum and not Spondylocladium can be accepted.

Vermicularia varians has been described by Ducomet* as producing a disease of potatoes in France, and the same disease apparently occurs in Australia† and South Africa‡. The published descriptions of this "dartrose" or "Black Dot" disease recall, to some extent, what one has seen of *Colletotrichum tabificum*; but whether there is any real connexion between these two fungi can only be decided by further study.

III. HYPOMYCES SOLANI Reinke et Berth.

This fungus was described by Reinke and Berthold§ in 1879, who stated that it was a pure saprophyte. Since the ascospores on germination gave rise to conidia which these authors took to be those of *Fusisporium Solani*, they regarded *Hypomyces Solani* as the perithecial stage of this species.

Fusisporium Solani Martius was renamed *Fusarium Solani* by Saccardo; and in the older literature this fungus was often regarded as a parasite and the cause of the "Dry Rot" of the potato tuber.

The investigations of recent years on the genus Fusarium have, however, shown that the name *F. Solani* has been used in the past for more than one species of this genus; and this doubtless explains some of the confusion that has arisen.

Hypomyces Solani in its perithecial stage does not appear to be very common. I have only found it on three or four occasions, and always on the surface of potato tubers in an advanced stage of decay; never on tubers still partially living. Several years ago I was able to obtain type material of the fungus which has been useful for purposes of comparison.

The object of the present study was to trace the complete life-cycle of *H. Solani* from ascospore to ascospore *in vitro*; to make a careful comparison between its conidial stage and some

* Ducomet, V. Ann. Ecole Nat. Agric. Rennes, ii, 1908.
† McAlpine, D. Potato Diseases in Australia, 1911, p. 92.
‡ Doidge, E. M. Agric. Journ. Un. South Africa, vii. No. 6, 1914, p. 879.
§ Loc. cit. p. 27.

of the species of Fusarium which commonly occur on the potato, and to settle the question as to whether it is a saprophyte or a parasite. The species of Fusarium with which it has been more closely compared in culture are *F. Solani* (Mart.) A. & W., *F. Martii* A. & W., *F. caeruleum* (Lib.) Sacc., *F. trichothecioides* Wr., *F. discolor* (A. & W.) var. *sulphureum* (Schlecht.) and *F. arthrosporioides* Sherb.

Large numbers of cultures on numerous different kinds of media have been studied and a variety of inoculation experiments carried out, but it is only proposed to give a brief account of some of the most important results here.

General growth in pure culture. The stock pure culture which served as the basis for all subsequent work was derived from a single ascospore. These spores germinate readily, each cell sending out a germ tube. A photograph of a germinated ascospore is shown in Fig. 1, Plate IV.

Growth on all media used was luxuriant, the aerial portion being usually copious and snow white. An eight-day old individual growing on wort-gelatine is illustrated in Fig. 2, Plate IV. No colour of any kind was ever developed, such as is characteristic of several species of Fusarium. The older growth, especially on media slanted in test tubes, is not fluffy or cottony, as a rule, but may rather be described as somewhat fibrous, that is to say, the hyphae combine laterally to form more or less pointed strands, roughly comparable with fibrous asbestos. None of the several species of Fusarium under study at the same time showed this kind of growth. The consorting hyphae are not merely mechanically adherent to one another but actual anastomoses or "H-shaped" unions are frequent. Cultures in Petri dishes show very distinct concentric zonation. One such culture is shown in Fig. 4, Plate IV. Each zone consists of a horizontal chiefly submerged vegetative growth of mycelium and a corresponding vertical, aerial growth, the latter consisting of conidiophores bearing conidia-globules and being formed during the night. Each zone requires twenty-four hours for its formation. Growth of this kind has not been observed in any species of Fusarium.

Conidiophores. These are usually long, erect, multicellular and simple. Conidiophores with one or two lateral branches are occasionally seen, but the mode and extent of branching does not resemble that typical of Fusarium. They are sometimes submerged in the medium. Very frequently they are aggregated together in the form of conical coremia, as described and figured by Reinke and Berthold; and much of the aerial growth of the fungus often consists of such coremia. The second type of much branched conidiophores figured by these

authors* and obtained by them from pustules on tubers and stems evidently does not belong to Hypomyces, but to some species of Fusarium. Hypomyces does not appear to form pustules breaking through the skin of the potato like some species of Fusarium do, and attempts to produce them by pure culture inoculation of both healthy and sterilised tubers with intact skins failed.

Conidia. The conidia are produced singly at the apex of the conidiophore. When the conidium is ripe it becomes pushed on one side and does not immediately fall off. As the formation of conidia proceeds, a globule—at first elliptical, then spherical—forms at the tip of the conidiophore. This consists of a mass of conidia held together in a slightly alkaline fluid, just as occurs in some species of Verticillium. Not infrequently neighbouring globules of conidia in a culture touch one another and coalesce, forming thus a much larger globule which is then supported on several coremia. These globules are seen in Fig. 3, Plate IV, and they can just be discerned with the naked eye in Figs. 2 and 4, Plate IV.

After the first conidium is formed the protoplasmic contents of the conidiophore contract slightly, and a minute, slightly expanded collar remains at the extreme tip. The conidium next arising grows up and becomes seated in this collar, looking in its early stages like an egg in a cup. (See Fig. 10, Plate III.) When the conidium has reached its full size separation occurs at its base between its protoplasm and that of the conidiophore and a slight gap is seen. Subsequently the base of the conidium and the slightly contracted contents of the conidiophore each develop a thin wall. Somewhat the same kind of thing was described for *Fusarium caeruleum*† and accounts for the development of the foot-like base of the conidium often seen in Hypomyces as well as in several species of Fusarium.

Typical conidia of *Hypomyces Solani* are 3-septate, i.e. 4-celled, but forms with less or more septa are not uncommon. The average of many measurements of typical 3-septate forms was found to be $38\mu \times 6{\cdot}2\mu$. Similar measurements for *F. Solani* were found to be $30\mu \times 5{\cdot}3\mu$ so that the conidia of the latter are considerably smaller than those of *Hypomyces Solani*. Examples of them are shown in Fig. 9, Plate III. On germination the two terminal cells of the conidium invariably produce germ tubes first; the intermediate ones either later or not at all. In *F. Solani* the cells of the conidium were observed to germinate more or less simultaneously.

* Loc. cit. Pl. I, Figs. 5 and 6.

† Pethybridge and Lafferty. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), No. 21, 1917, p. 204.

Chlamydospores. Reinke and Berthold refer to these as macroconidia and to the fusiform conidia as microconidia, following Tulasne's terminology. As a matter of fact the chlamydospores are smaller than the conidia, and there seems no adequate reason for retaining these somewhat obsolete terms. There is practically nothing to add to Reinke and Berthold's description of these spherical spores. They were produced in considerable numbers in all cultures but not so freely as the conidia. They developed extraordinarily abundantly in a sterilised cold water extract of ground Quaker Oats.

Their walls are thicker than those of the conidia and they are often more or less "warty," although this irregular thickening varies somewhat in different media and is sometimes completely absent. They germinate readily enough, but probably are more resistant to adverse conditions than the conidia and may serve, therefore, as resting spores. No experiments, however, were made on this point. A germinating chlamydospore is illustrated in Fig. 11, Plate III.

Development of Perithecia. During the first three or four months that the fungus was cultivated no perithecia were formed on any of the media used. Since they occur naturally on rotting potato tubers, special attention was devoted to culture on these. The fungus was planted on tubers affected with blight (*Phytophthora infestans*) both sterilised and unsterilised, as well as on sterilised tubers affected with "Pink Rot" (*P. erythroseptica*). Luxuriant growth developed in all cases but no perithecia were formed, although the cultures were kept under observation for fifteen months.

During the winter of 1913–14, the detailed culture work was suspended, but the stock culture was kept going by transfers at monthly intervals, mostly on oat extract agar, all the intermediate transfers being kept. After the fungus had been in culture for nearly a year perithecia began to develop both in some of the older transfers, which had been kept, and in the more recent sub-cultures on oat extract agar.

It would appear, therefore, that the fungus requires a more or less prolonged period of growth under artificial conditions, before it becomes stimulated to produce its perfect form of fructification. Having once reached this stage, the production of perithecia proceeds more rapidly. Thus, from a culture in which perithecia were present sub-cultures were made on sterilised potato stalks and sterilised portions of tubers, and within a month perithecia were developed. They were also formed on oat extract agar, Quaker Oat agar and beer-wort gelatine, but not quite so rapidly. In no case were they formed

in these media as freely and abundantly as on decaying tubers under natural conditions.

The form and structure of the perithecia have been described in detail by Reinke and Berthold, and there is little to be added in this connexion. When ripe the ascospores are expressed through the mouth of the perithecium in the form of a yellow mass. Perithecia with two necks have occasionally been observed in naturally growing material but they were not seen in any of the cultures.

Inoculation Experiments. Healthy living potato stalks, tubers and rhizomes were inoculated at various times and repeatedly with ascospores, conidia and mycelium bearing both conidia and chlamydospores, but no infection occurred in any single case and no rot was set up. *Hypomyces Solani*, therefore, is a saprophyte which in addition to its perithecial stage produces conidia and chlamydospores resembling in some respects those produced by certain species of Fusarium. There are, however, pronounced differences between typical species of Fusarium and the conidial stage of Hypomyces, and it is concluded that *H. Solani* is not the perithecial stage of *Fusarium Solani* or of any other species of Fusarium.

IV. TWO NEW SPECIES OF VERTICILLIUM.

In a previous paper* dealing with the disease of the potato plant caused by *Verticillium albo-atrum* R. et B. attention was called to the discovery of two new species of Verticillium, occurring on the surface of potato tubers, which, in the absence of infection experiments or study in cultures, might easily be mistaken for *V. albo-atrum*. Indeed, it seems not at all unlikely that it was the presence of one or the other of these species on the surface of the tuber which led Berthold and Reinke into the error of supposing that *V. albo-atrum* did not actually enter the tuber, as it has now been proved to do, but reached the developing sprouts from without, after having traversed the outer surface of the tuber. A brief description of these two species seems, therefore, desirable.

One of them, which it is proposed to call *V. nubilum*, was found at a spot on the surface of a tuber attacked by *Phytophthora infestans* where the skin had received a slight mechanical injury; the other, *V. nigrescens*, on the skin of a tuber affected with ordinary "scab." Both were obtained in pure culture, starting from a single conidium in each case, and both were grown on a large number of different solid and liquid media

* Pethybridge, G. H. The Verticillium Disease of the Potato. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), No. 7, 1916, p. 75.

and the growths compared with one another and with that of *V. albo-atrum* on the same media.

In their conidial form all three species are much alike, so far as their aerial parts are concerned. The conidiophores are very similar in each case. The size of the conidia in each species varies considerably, but parallel cultures on the same media showed that those of *V. albo-atrum* were on the average the smallest, and those of *V. nubilum* the largest; while those of *V. nigrescens* were intermediate. The measurements were made on what were considered to be the predominating type of conidia, omitting the extreme forms in each case.

The most striking differences are to be found in those portions of the growths which are submerged in the culture medium. In all three cases this submerged growth becomes dark after a time, and finally almost black. In the case of *V. albo-atrum* this darkening, as is well known, is caused by the turning black of the submerged hyphae. In *V. nubilum* and *V. nigrescens*, on the other hand, it is due, not to any change in the colour of the submerged mycelium, but to the production of large numbers of what may be regarded as chlamydospores which develop very dark, almost black, walls.

The chlamydospores of *V. nubilum* are more or less spherical cells hyaline at first, but soon developing thickish, dark brown or black walls. They may be borne singly or in groups of up to seven or so. They may be terminal but are frequently intercalary in rows of three or four or more. Examples are illustrated in Fig. 5, Plate IV. They are not, however, produced on all media and are usually absent in those containing gelatine. The mycelium on which they are formed remains visible for a long time.

The chlamydospores of *V. nigrescens* are considerably smaller than those of *V. nubilum*. They may be spherical, oval or somewhat pear-shaped. Generally they are single-celled, but occasionally they are septate. Many of them arise in an intercalary fashion by the thickening and blackening of non-contiguous cells in a hypha, and they retain, more or less, the shape of such cells. Often they are laterally sessile and then generally spherical. The cells of the hyphae which do not become chlamydospores become rather indistinct in old cultures, and the general impression is that of a row of irregular beads arranged at unequal intervals along, or at the side of, a faintly visible band. Examples are illustrated in Fig. 6, Plate IV. They are developed in very large numbers; and the blackening of the medium produced by them is considerably more intense than that caused by the two other species.

Although the two fungi were kept continuously in culture

for three years, no reproductive organs, other than conidia and chlamydospores, were ever observed.

A considerable number of inoculation experiments were carried out with these two species on living potato stalks and tubers. In no case did infection occur and there was no indication of any ability to invade or grow in the vessels of the wood such as characterises the parasitic *V. albo-atrum.*

The characters of these two species may be summed up as follows:

VERTICILLIUM NUBILUM Pethybridge.

Mycelio albo effuso; ramis fertilibus ascendentibus, verticillatis; conidiis continuis, oblongatis, hyalinis, magnitudine varia plerumque $9\mu \times 3\mu$; hyphis in matrice submersibus chlamydosporis moniliformis vel conglobatis subglobosis, atris 8·5–12μ diam.

Hab. In tuberis putrescentibus *Solani tuberosi*, in Hibernia.

VERTICILLIUM NIGRESCENS Pethybridge.

Mycelio albo effuso; hyphis fertilibus erectis, ramis verticillatis; conidiis hyalinis, continuis, oblongatis, magnitudine varia plerumque $7\mu \times 2\mu$; mycelio in matrice submerso, chlamydosporis terminalibus, vel lateralibus, vel intercalariis, aut globosis, circ. 4·3μ diam., aut sub-ovalis, circ. $6\mu \times 4\mu$ atris.

Hab. In tuberis scabiosis *Solani tuberosi*, in Hibernia.

V. LANGLOISULA MACROSPORA A. L. Sm.

When examining blighted potato foliage in the search for possible oospores of *P. infestans*, isolated brown spores were again and again met with, the origin and identity of which were not clear. The same spores have also been met with on blighted tubers.

No difficulty was experienced in getting a pure culture from these spores, and the resulting fungus was identified by Mr. J. Ramsbottom and Miss A. Lorrain Smith as *Langloisula macrospora* by comparison with type material in the British Museum. This species was described in 1901 by Miss Smith* who found it spreading over a grass seed in the germinating case.

On agar media the submerged mycelium is hyaline and about 3μ thick. Over the surface of the medium much larger hyphae about 9μ thick run, and from these conidiophores arise here and there in more or less isolated tufts or balls. The

* Smith, A Lorrain. Fungi found on farm seeds when tested for germination; with an account of two Fungi new to Britain. Journ. Roy. Microscop. Soc. 1901, p. 617. In the description in the text the species-name *heterospora* is given but this is probably a misprint for the name *macrospora* which is applied to the figures on the accompanying plate and which is given to the fungus in the account published in Trans. Brit. Myc. Soc. i. 1902, p. 194.

hyaline conidiophores develop in a peculiar sympodial fashion which give them a zig-zag appearance as illustrated in Fig. 12, Plate III.

The conidia are egg-shaped and brown in colour. The wall is slightly thickened but it is not nearly so thick as would appear from Miss Smith's drawings. Nor is it so strongly thickened as is shown in figures of the conidia of *L. spinosa* Ell. et Everh. In young conidia the wall is quite smooth and not warty. In old cultures the wall is slightly rough, but even in this condition can scarcely be described as warted. Careful examination of old conidia shows that the outermost portion of the wall is not continuous over the whole conidium and the slight roughness is due to this fact.

The conidia germinate easily, a germ tube being produced at the narrower end through a thin place in the wall at the point where the conidium was attached to the conidiophore. A germinating conidium is illustrated in Fig. 13, Plate III.

Attempts were made to infect living potato leaves (both intact and wounded) as well as stems and tubers, but without success. The fungus is a saprophyte.

As regards the systematic position of the fungus, it seems doubtful whether it should really be placed in the genus Langloisula. Its conidiophores are not dichotomously branched as in the type of that genus, and its conidia are not so thick walled. Miss Smith and Mr. Ramsbottom suggested to me that it would perhaps be better placed in the genus Monopodium of Delacroix*. Material was sent to Paris for comparison with Delacroix's specimens, but unfortunately no type material of them had been preserved.

M. Arnaud was good enough to look into the matter, however, and found that the specimen sent agreed exactly with an unpublished drawing by M. Griffon which the former believed to represent Delacroix's Monopodium. M. Arnaud further suggested that both the Monopodium of Delacroix and *Langloisula macrospora* were probably identical with *Acremoniella atra* Corda, and pointed out that the specimen of Langloisula forwarded resembled Saccardo's† drawing of this species rather more closely than the original one of Corda‡.

In concluding these notes I desire to acknowledge gratefully the assistance given me, in cultural and other work with the organisms described, by Mr. H. A. Lafferty, A.R.C.Sc.I., who was also good enough to prepare the drawings for the figures on Plate III.

* Bull. Soc. Myc. France, vi. 1890, p. 99.
† Fungi Italici. No. 713.
‡ Icon. Fung. i. Tab. III, fig. 168.

EXPLANATION OF PLATES.

Plate III.

(All figures were drawn with the aid of a Zeiss Camera Lucida.)

Fig.

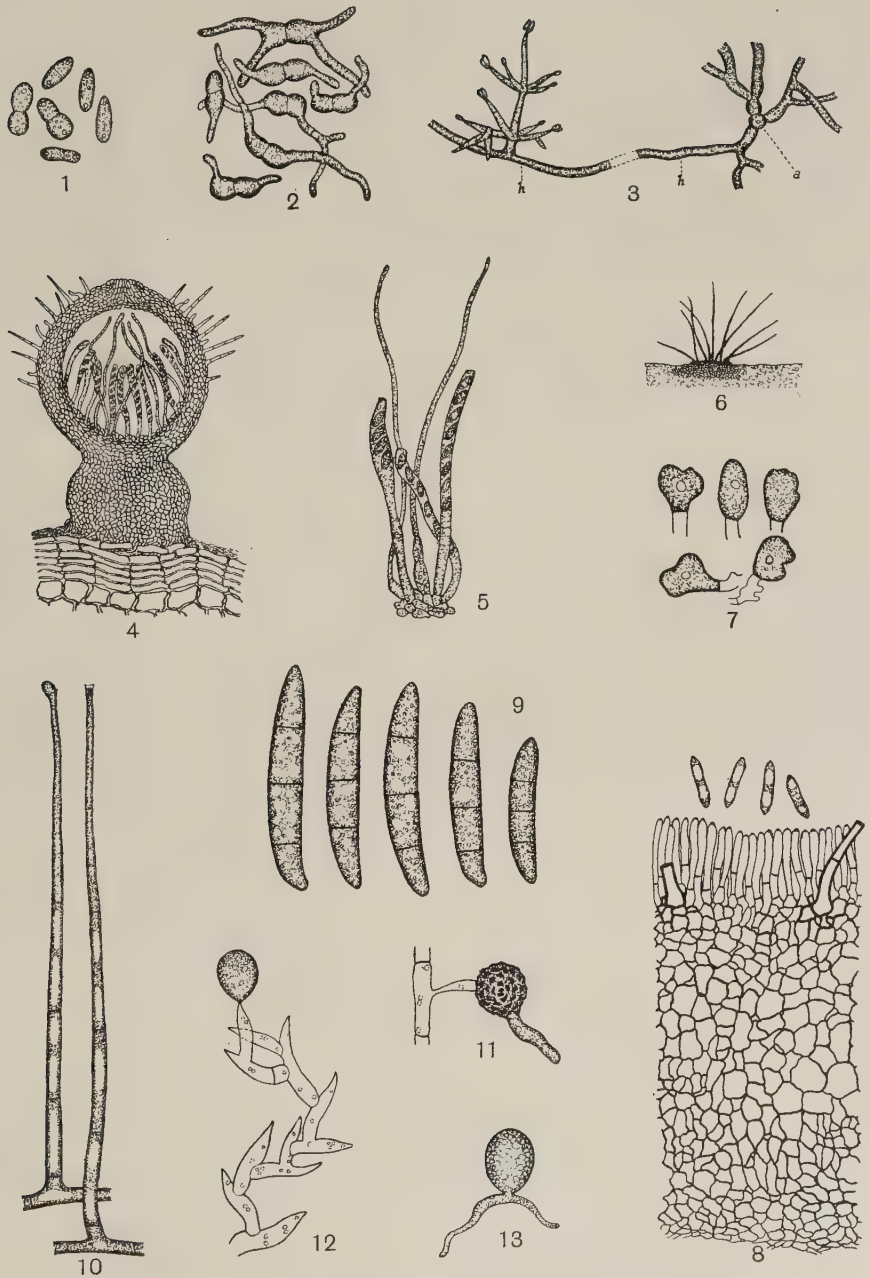
1. Unripe (single-celled) and ripe (two-celled) ascospores of *Nectria inventa*. × 547.
2. Ascospores of *N. inventa* in various stages of germination in tap water. × 547.
3. An ascospore (*a*) of *N. inventa*, the germination and subsequent development of which on a cover-glass film was followed uninterruptedly under the microscope. The hypha *h*, *h* was continuous and developed on the left a characteristic conidiophore bearing conidia of *Verticillium cinnabarinum*. × 333.
4. Vertical section through a perithecium of *N. inventa* on its stroma. The section is not quite median and therefore does not pass through the ostiole, although the near presence of the latter is seen from the arrangement of the cells at the top. For the sake of clearness a large portion of the contents of the perithecium has been omitted. In an actual section the paraphyses are not nearly so clearly defined as is shown, owing to crowding. The mycelium permeating the cork-cells of the skin of the tuber on which the stroma sits, although present in the section, has been omitted from the drawing. × 55.
5. Portion of the contents of a perithecium of *N. inventa* teased out, showing the asci and septate paraphyses with rather swollen bases. × 340.
6. Young "sclerotium" (acervulus) of *Colletotrichum tabificum* on a potato stalk. The long black setae have penetrated through the epidermis but the remainder is still submerged in the tissue. × 91.
7. Appressoria of *C. tabificum* as developed in pure culture. × 560.
8. Vertical section through the acervulus of *C. tabificum*, as developed in pure culture. Four ripe conidia are shown isolated. The upper surface consists of a palisade-like layer of septate conidiophores, and the basal portions of two setae are shown. The lower part consists of rather thin walled pseudo-parenchymatous tissue. × 340.
9. Typical conidia of *Hypomyces Solani* from a 30-day old culture on oat extract agar. × 560.

Fig.

10. Two conidiophores of *H. Solani* from a 30-day old culture on a sterilised potato stalk. The one on the right shows the "collar" at its apex, that on the left is in process of developing a fresh conidium. × 340.
11. Germinating chlamydospore of *H. Solani*. × 560.
12. Conidiophore of *Langloisula macrospora*. × 340.
13. Germinating conidium of *L. macrospora*. × 340.

Plate IV.

1. Portion of the mycelium produced from a single ascospore (seen in the centre) of *Hypomyces Solani* in four days on a wort-gelatine cover-glass film. × 200.
2. An 8-day old individual of *H. Solani*, developed from a single ascospore on a wort-gelatine. The very numerous globules of conidia can just be seen with the naked eye as black dots. × 10.
3. Portion of the individual shown in Fig. 2, showing the conidiophores with their terminal globules of conidia.
4. A culture of *H. Solani* on oat extract agar, eleven days old. The first six days' growth occupies the centre and is more or less blurred by the presence of the large numbers of conidia-globules, many of which have fused together. The growth during the subsequent five days is clearly zoned. The lighter circles consist of aerial conidiophores, bearing conidia-globules; the darker, wider bands consist of more or less submerged mycelium. A dark and a light band, forming one zone, developed each 24 hours, the light circle of conidiophores being produced last and during the night. × $1\frac{1}{4}$.
5. Groups of chlamydospores of *Verticillium nubilum* from a pure culture on oat extract agar. × 360.
6. Chlamydospores of *V. nigrescens* from a pure culture on oat extract agar. The mycelium which bore these spores is now practically invisible. × 310.



H. A. Lafferty del.

FURTHER NOTES ON COLUS GARDNERI (BERK.) FISCHER.

With Plate V.

By T. Petch, B.A., B.Sc.

Colus Gardneri was described by Berkeley under the name of *Lysurus Gardneri* in Hooker's London Journal of Botany, v. p. 535. In "Versuch einer systematischen Uebersicht über die bisher bekannten Phalloideen" (1886), Ed. Fischer transferred it to Colus. The description, as given in Saccardo, is: "Receptaculo elongato, stipitiformi 17–18 cm. alto; stipite longo (15 cm. alto) superne dilatato in partem clathratam apicem conicum receptaculi efformantem transeunte; partis clathratæ interstitiis 5, verticalibus, linearibus; ramis superne attenuatis, apice junctis, extus medio structura stipiti æqualibus, latere rugosis."

In Grevillea, xix. p. 94, Massee wrote, "Berkeley, in describing the present species [*Lysurus Gardneri*], says that the vertical lobes bearing the hymenium are united at the tips, and on this account the species has been removed to the genus Colus by Fischer; but in reality the segments are not organically united at the tips, but during the young stage are closely pressed together, and having been dried in this condition appear to be united; however, when the mucilage is moistened the tips are found to be quite free, and are normally so in several out of the twenty-three specimens from Gardiner (*sic*) in the Kew Herbarium. The above is an average illustration as to how synonyms originate, i.e., by manipulating descriptions and not specimens, which, however, answers the desired object, that of enabling the manipulator to bracket the founder's name and bring his own to the front."

Whatever may be the condition of the Kew specimens now, there can be no doubt that Massee's statement is incorrect. The fungus is not common at Peradeniya, but I have gathered and examined over thirty specimens and in all of them the arms are "organically united" at the apex. They are not glued together by mucilage, nor united by a membrane, but each arm is continued as a tube up to the apex where it is continuous with the others.

In "Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen" (1890), Fischer retained this species in the genus Colus. He had examined a specimen from Berkeley in Herb. Mus. d'Hist. Nat., Paris, but was unable to determine the nature of the dorsal line of the arm and the apex. Fischer stated that *Colus Gardneri* is, as it were, *Colus hirudinosus* in which the stalk has lengthened and the apical meshes disappeared, or an Anthurus with its arms united at the tip; it differed from Lysurus in that in the latter the stem structure was not continued into the arms; in *C. Gardneri*, as in Anthurus and the other species of Colus, the stalk expands gradually to the receptaculum, whereas in Lysurus it is constricted above as in *Simblum sphaerocephalum*.

In "Neue Untersuchungen" (1893) Fischer wrote "In Berkeley's and the Kew Herbarium there are numerous examples of this fungus, all from Ceylon. I was able to determine with certainty on some of them that the arms are actually united at the apex, though the junction is extraordinarily thin. But the possibility is not excluded that examples may occur in which the arms are free. Further, it is characteristic of this species that the lowest part of the arm is free from spores, and, correspondingly, is not transversely wrinkled."

In "Untersuchungen zur vergleichenden Entwicklungsgeschichte," etc. (1900), Fischer notices Massee's statement in Grevillea and refers his readers to his views expressed in 1893.

In 1907, C. G. Lloyd published "The Phalloids of Australasia," and gave copies of the figures of *Lysurus australiensis* and *Mutinus pentagonus*, which, in general appearance, closely resemble *Colus Gardneri*. Lloyd expressed his opinion of the latter in the following terms. "The early stages of Lysurus with the arms connivent have led to some very misleading pictures. Thus, Berkeley's original picture of *Lysurus Gardneri* so misled Professor Fischer that he transferred it to another genus, but after he visited Kew and saw that it misrepresented the plant he should have transferred it back. Our American species *Lysurus borealis* was named *Anthurus borealis*, but in my opinion is a Lysurus, and I think the same as the Ceylon species. It was originally illustrated with a drawing subject to the same criticism as the original drawing of *Lysurus Gardneri*" (p. 12). "*Lysurus Gardneri* of Ceylon, which was so named and described by Berkeley, is a true Lysurus with spreading arms, and not a Colus, as found in Fischer's latest work. Fischer referred it to the genus Colus on the strength of Berkeley's figure, and he was justified, if one is ever justified in changing classification on the evidence of a figure. When Professor Fischer came to Kew, however, and saw the specimens,

he should have receded from his position, for it is quite evident that the plant is a Lysurus, and not a Colus in any sense of the word. The arms are entirely separate and spreading when mature. Like all species of Lysurus, they are connivent when young, but they are not joined at the apex, however slightly" (p. 14).

In 1908, the present writer redescribed *Colus Gardneri* in "The Phalloideae of Ceylon" (Ann. Perad. iv. pp. 139–184), pointing out that the arms are always united at the apex, and that the structure of the gleba-bearing area of the arms is similar to that of the cap of *Dictyophora irpicina* (*Clautriavia irpicina*). Additional details were published in "Further Notes on the Phalloideae of Ceylon" (Ann. Perad. v. pp. 1–21).

In "Synopsis of the known Phalloids" (1909) Lloyd adopts Berkeley's name *Lysurus Gardneri* for the Ceylon species. Under "The Genus Lysurus," he writes: "This genus has been very much misunderstood though of a very simple structure. It consists of free arms borne on a hollow columnar stem. The gleba is borne on the arms. It has been shown that in the original species the gleba is borne on the outer side of the arms, hence species with gleba on the inner surface of the arms have been transferred to Anthurus, which genus does not have a columnar stem. I think it is much simpler to define Lysurus as originally defined, viz.: a columnar stem bearing free arms at the apex. With respect to the position of the gleba, there are evidently two series, and a new genus will probably be made for those with the gleba on the inner side of the arms. It has recently been shown by Mr. T. Petch, Ceylon, that the arms of *Lysurus Gardneri* (which was the second species known) are not entirely free, but are united by a delicate membrane. We would therefore modify the definition of the genus to include species with arms free or very slightly united."

In the second of the publications referred to above, I have pointed out that the junction of the arms is not a delicate membrane.

Lloyd's final conclusions on the subject are contained in Mycological Notes, No. 43 (Sept. 1916), p. 594. They are quoted here in full.

"We present herewith a sketch of *Lysurus Gardneri*, recently sent us by C. C. Brittlebank, Melbourne. In our Phalloid Synopsis, we presented nine species of Lysurus, and the evidence since is that four of them, viz., *Lysurus Gardneri* (Ceylon), *Lysurus australiensis* (Australia), *Lysurus borealis* (United States), and *Lysurus Clarazianus* (Argentina) are all one and the same thing. We have believed it for a long time, and there was no longer any room for doubt on the appearance of 'Notes

on Australian Fungi, No. 2,' August, 1915, by Dr. Cleland and Edwin Cheel. We suspected it from the first, but Professor Petch maintained that *Lysurus Gardneri* had its arms joined by a membrane at the apices, which was not the case as far as known in the other species. Messrs. Cleland and Cheel have satisfactorily explained this. In Australia, while the arms are usually free, they are sometimes 'united at the apex by a thin membrane which gives the specimen a somewhat clathrate appearance.' The figure 836 which we produce from Messrs. Cleland and Cheel presents the top of a young specimen with two of the arms joined. Mr. Brittlebank's sketch (Fig. 835) shows the arms connivent, as they are at first. They afterwards spread out, as shown in the fine photograph by Hollis Webster, published in Mycological Notes, p. 513.

"There is a long story connected with the species. First it was sent Berkeley from Ceylon and named *Lysurus Gardneri*. It is rare in Ceylon, but recently collected by Professor Petch. One collection reached Kew from Australia (Bailey, Brisbane River) which Cooke named *Lysurus australiensis*, and gave in the Handbook a most inaccurate and exaggerated drawing of it. It seems to not be common in Australia, though there are twelve collections in the National Herbarium, Sydney. Fischer gives a very good figure of it from Argentina under the name *Lysurus Clarazianus*. The European and American history is all recent, for it is supposed to be introduced into both these countries. With us it was first collected at East Galway, New York, by Professor Burt in 1893. He published it as *Anthurus borealis* under a misconception of the genus Anthurus. A few stations were added from time to time (Cfr. Myc. Notes, pp. 183, 219, and 515), and of late years it is sometimes found in abundance. It seems to grow where sod has been turned and rotted. In Europe it has been collected once in Germany, and twice in England (Cfr. Syn. Phalloids, p. 40), no doubt adventitious. The native home of the species is probably the East (Ceylon and Australia). Cleland and Cheel consider that *Mutinus pentagonus* (Syn. Phalloids, Fig. 28) is the same plant. I examined the specimens at Kew, and I thought the arms were consolidated in one piece. If they separate, then I think it is *Lysurus Mokusin* of China, which differs from *Lysurus Gardneri* in having an angular, fluted stem. Petch in his latest work insisted that the Ceylonese plant and Australian are not the same."

The opinions expressed by the different mycologists who have dealt with *Lysurus Gardneri* from Ceylon and *Lysurus australiensis* from Australia have, of course, been based on drawings and dried specimens, and they are the best possible on that

material. Of recent years, the systematic study of Australian fungi (as distinct from plant pathology) has been vigorously pursued by Dr. J. B. Cleland and Mr. E. Cheel, and thanks to them we are now able to obtain material in a condition more suitable for investigation. In order to decide the identity, or otherwise, of *Lysurus Gardneri* and *Lysurus australiensis*, I sent specimens of the former, in alcohol, to Dr. Cleland, and, in return, Mr. Cheel has very kindly forwarded specimens of the Australian species in formalin. Comparison of the two species shows that they are entirely different. Each has a stalk and five arms, but there the resemblance ends.

Before proceeding to enumerate the differences between the two species named, it may be as well to call attention to a point in the classification of phalloids which has not received the consideration it should. In spite of Fischer's work, there appears to be too great a tendency to base the systematic arrangement of this group on general appearance, and to ignore details which, to some, seem to be more important. We do not group the Dog Rose and the Christmas Rose together, even though to the casual observer their flowers may look very much alike.

In all the phalloids, the gleba is borne on certain definite areas. The main mass of the plant may be regarded as a foundation or scaffolding on which the gleba-bearing regions are situated. The foundation is, in general, composed of chambered tissue, and its surface usually bears close-set convex elevations, which represent the outer walls of the chambers. But the surface underlying the gleba is usually of a different nature, and in many genera it has a characteristic form. This surface may be called the glebiferous layer, from its function, without any necessary implication as to its origin.

It is generally recognised that the shape of the foundation may vary to a considerable extent. A species which usually has five arms may sometimes have four or six. A stalk which generally consists of three layers of chambers might conceivably have only two; Cleland and Cheel suggest such a variation to account for the fact that the wall of the stalk of *Lysurus australiensis* has usually three layers of chambers, while that of the supposed identical *Lysurus Gardneri* has usually only one. In *Aseroë rubra*, the number of arms varies considerably, and while some specimens have narrow simple arms, others may have broader bifid arms owing to the partial fusion of adjacent pairs, and in yet others, all the arms may be fused in pairs to form broad simple arms; stages of this variation may be found on opposite sides of the same specimen. But

what is often not recognised is that the form of the glebiferous layer is practically constant.

In Mutinus, the glebiferous layer consists of a series of close-set slightly-elevated tubercles. Jansia is indistinguishable from Mutinus when the head is covered with gleba, but when the gleba is removed, the glebiferous layer (in the type species) is found to bear numerous scattered appendages. Hence Jansia is distinguished from Mutinus by the form of the glebiferous layer.

The point I would wish to emphasise is that, in classification, the shape of the glebiferous layer, as well as the general shape of the foundation, should be taken into account. Otherwise, the classification would appear to be in the same category as a classification of flowering plants based on general form and habit.

Dictyophora offers a standard example. *Dictyophora irpicina* is of the same general form as *D. phalloidea*. When the cap is covered with gleba, there is nothing evident to indicate that the two are not structurally alike. But when the gleba is removed, the latter is found to have its cap widely reticulated with high, narrow ridges, while the cap of the former has an irregular granular appearance, due to the fact that its glebiferous layer consists of innumerable thin processes and contorted plates, perpendicular to the basal layer and closely packed together. Recognising this difference, Fischer divided Dictyophora into two sections, Reticulati and Rugulosi. Recent writers have gone further and have raised Patouillard's section Clautriavia, which is Fischer's Rugulosi, to the rank of a genus.

According to the idea outlined above, it is not possible to classify an unknown phalloid accurately, unless the gleba is washed off and the glebiferous layer examined. If this test is applied to *Lysurus australiensis* and *Lysurus Gardneri*, it is immediately clear that the two species are not the same and do not even belong to the same genus. The glebiferous layer of *Lysurus australiensis* consists of smooth broad folds or wrinkles; that of *Lysurus Gardneri* is rough and granular, of the same nature as that of *Clautriavia irpicina*. If *Dictyophora irpicina* is admitted to be generically distinct from *D. phalloidea*, there can be no escape from the conclusion that *Lysurus Gardneri* is generically distinct from *L. australiensis*.

The arm of *Lysurus australiensis* bears a glebiferous layer along the whole of its length. Laterally, this layer extends nearly round the arm, leaving, however, a shallow longitudinal furrow on the outer side free from gleba. It is composed of a series of close-set horizontal wrinkles, each 0·4–0·5 mm.

broad. These wrinkles seldom extend right across the arm, but those which begin at the sides thin out and are finally wedged between others which arise on the inner face. The separate wrinkles have a smooth white rounded outer edge. In longitudinal section, it is seen that these wrinkles are merely folds in the wall of the arm.

The arm of *Lysurus Gardneri* bears its glebiferous layer along the middle two-thirds or three-quarters of its length, the base and apex being free. The layer extends laterally almost completely round the arm, being interrupted by a deep narrow furrow on the outer side. This furrow is usually so narrow that it is hidden by the projection of the gleba over either edge. The glebiferous layer is slightly furrowed transversely, but the whole surface is minutely granular, the granules being the ends of thin processes, or the irregular edges of contorted plates, so closely packed together that their outer ends form a continuous surface. These processes arise from the wall of the tube which forms the arm, and as they are 1·5–2 mm. long, they constitute the greater part of the thickness of the arm. As in *Clautriavia* (*Dictyophora*) *irpicina*, the glebiferous layer, after the removal of the gleba, is dark olivaceous, not white.

The above is the fundamental distinction between the two species. *Lysurus australiensis* has a glebiferous layer, similar to the commoner type in phalloids; *Lysurus Gardneri* has a "rugulose" glebiferous layer, practically identical with that of *Clautriavia irpicina*.

The less important points of difference are numerous, and would be sufficient to maintain the two species distinct, if they belonged to the same genus.

The arm of *Lysurus australiensis* is irregularly chambered below, and becomes a simple tube, with a wrinkled wall, above. The wrinkled glebiferous layer is continued from arm to arm round the sinus between the arms. (It may be noted that a continuation of the gleba may mean nothing, because the soft gleba mass may be washed down into an abnormal position, but, on the other hand, the continuation of the glebiferous layer postulates a definite type of structure.) The head of *L. australiensis* may be roughly compared to a star-shaped disc, perforated in the centre, glebiferous along the whole outer edge, the points of which have been turned up. The comparison is not a very accurate one, as it ignores the continuation of the glebiferous tissue across the inner surface of the arms. But it may serve, as it illustrates also the fact that the "head" consists not only of the arms, but also includes the upper edge, or rim, of the tube which constitutes the stalk. This "head"

is separated from the stalk by a distinct constriction, in most cases. This distinction between stalk and head, and the continuation of the glebiferous layer from arm to arm at its base were noted by Fischer: the points are clearly shown in Brittlebank's figure.

The arms of *L. australiensis* are apparently glebiferous to the apex: in section they are obtusely triangular, the rounded apex of the triangle being on the inner side. The stalk in cross section is composed of several layers (usually three) of small chambers.

In *Lysurus Gardneri*, the glebiferous layer is not continued below from arm to arm. The stalk divides at the apex into five small stalks, and these do not bear any glebiferous layer for a length of two to four millimetres. Their structure in this basal region is the usual chambered stalk structure, and in cross section they show two large chambers. Above that region, each arm becomes a simple tube, bearing on its outer wall the closely-packed processes which constitute the glebiferous layer. The diameter of the arm, which is about 3 mm. in the stalk region, is increased to 6 mm. in the glebiferous zone, the increase being due to the length of the processes. Towards the apex, the glebiferous layer ceases, and the arm is continued as a narrow simple tube. In this species, consequently, there is no "head" sharply defined from the stalk: each arm is borne on its own stalk.

In section the arms of *Lysurus Gardneri* are oval, with a narrow groove along the outer face. The groove results from the absence of the glebiferous layer, with its long processes, from a narrow longitudinal band. The stalk is composed, as a rule, of a single layer of chambers, greatly extended longitudinally, but it may have two layers.

The discussion as to the identity of *Lysurus Gardneri* and *Lysurus australiensis* has usually centred on the minor point whether the arms are united or not at the apex. In *Lysurus Gardneri*, each arm is continued as a narrow tube to the apex, where it is united with the other arms, the tube structure being continuous over the apex. This feature is constant in all the fresh specimens examined, and it is clear from the structure that any separation of the arms could only be the result of an accidental fracture. In *Lysurus australiensis*, the arms are said to be usually free at the apex, but specimens are found in which the arms are united. In one of the specimens sent me by Mr. Cheel, one of the arms is subacute and closed at the apex; the remaining four are perforate and truncate at the apex, and one of them bears at the top a short length which, from its expansion upwards, evidently belongs to one of the

other arms. In another specimen, two arms are clearly united, the wrinkled structure being continuous from one to the other. But it is surely misleading to call such a junction a "Membrane"; this one is a tube 1·75 mm. in diameter.

From the specimens submitted to me, I should deduce that in the young state, in the egg, and probably immediately after expansion, *Lysurus australiensis* has one or more arms free and others united in pairs, and that some time after the plant has expanded the junctions break. If the egg were obtained and the plant allowed to expand under a bell glass, this could easily be determined.

Fortunately, the distinction between *Lysurus Gardneri* and *Lysurus australiensis* does not depend on the question whether the arms are united or free, and we are consequently spared the trouble of discussing which characteristic should be attributed to Lysurus as a genus. But the case illustrates a point which will always bother the classifiers of phalloids, as long as they have to depend on chance collections of expanded specimens. For a phalloid is one of the most ephemeral of tropical fungi, and the collector who does not gather his specimens in the early morning cannot gain a correct knowledge of their original form.

The question which perennially arises in the study of phalloids is this: Are we to describe a phalloid from specimens which have just expanded and are therefore in the most perfect condition, or from specimens which have been expanded for some hours and have begun to collapse? It is surely incorrect to base classification and discuss affinities on details which only exist in old, broken specimens.

Setting aside Lysurus as an unsettled case, we may take Dictyophora as an example. When *Dictyophora phalloidea* first expands, its net is rigid and stands out like an old-time crinoline, but in the course of an hour or two, the net collapses into folds, after the manner of a modern (?) petticoat. But there appears to be a general agreement that the net of Dictyophora hangs in folds, and it has been suggested that a new species should be founded on Möller's figure, which shows a rigid net. Again, *Simblum periphragmoides* has a subglobose, netted head at the apex of a stout stalk. When first expanded, the head rests on the top of the stalk like a ball on a stick, but, after a few hours, the basal bars of the net weaken and collapse, and the head sits down on the stalk and sags over the edge. The collapsed form has been made a new species. As an extreme example, *Clathrus crispatus* may be cited. This is a large Clathrus, 20 cm. diameter, with massive arms and small meshes. Half an hour after expansion, it breaks up spon-

taneously into fragments. Is *Clathrus crispatus* to be described as a heap of fragments? It would appear self-evident that if classification is to be based on the general shape of phalloids, it must be on the perfect shape, immediately after expansion, before they have collapsed or broken.

The type species of the genus Lysurus, *L. Mokusin*, appears from the available figures and descriptions to be so different from the other species assigned to Lysurus, that it would seem preferable to confine the genus to it alone. From the photograph of *Lysurus borealis* in Lloyd, Myco. Notes, p. 513, it appears clear that that species has wrinkled arms similar to those of *Lysurus australiensis*. From Fischer's description, and Möller's figure as reproduced by Lloyd, *Lysurus Clarazianus* has the same wrinkled arms. Of the remaining species enumerated by Lloyd, *Lysurus Woodii* (MacOwan), *L. Sanctae-catharinae* (Ed. Fischer), and *Lysurus cruciatus*, there does not appear to be any definite information regarding the structure of the arms.

The type species of the genus Colus is *Colus hirudinosus* Cav. & Sech. Its short stalk divides above into several stalk-like arms, which support a netted head. Hence Fischer was justified in comparing *Lysurus Gardneri* to a Colus in which the apical meshes had disappeared. Its arms appear to be transversely wrinkled.

The genus Pseudocolus is attributed, in Saccardo, xxi., to Fischer, but it was apparently established by Lloyd, Phalloids of Australia (1907), p. 18, for the reception of *Colus Rothae* Fischer, *Colus javanicus* Penz., *Colus Garciae* Möll., *Colus fusiformis* Fischer, and *Pseudocolus rugulosus*. These species have a short stalk which bears three arms, united at the apex. It may be noted that unless the genus Pseudocolus is confined to species which have only three arms, *Lysurus Gardneri* should, if the general shape of the plant alone is considered, have been included in it; Fischer, indeed, grouped *Colus* (*Lysurus*) *Gardneri* with *Colus javanicus* and *Colus Garciae*. Length of stalk can scarcely be regarded as a generic difference.

Pseudocolus Rothae is insufficiently known; its arms are described by Fischer as wrinkled, but Cleland and Cheel state that the species they attribute to this has arms which are alveolar on their inner surface. *Pseudocolus Garciae*, from Möller's figure and description, has coarsely wrinkled arms. *Pseudocolus javanicus* is described and figured by Penzig as having lamellae in groups on the arms. *Pseudocolus fusiformis* and *Pseudocolus rugulosus* have not been adequately described or figured.

On the available evidence, none of the species of the genera

Lysurus, Colus, and Pseudocolus, except *Lysurus Gardneri*, has a glebiferous layer composed of closely-packed processes and plates, such as occurs in *Clautriavia irpicina*. I therefore propose to establish a new genus Pharus for *Lysurus Gardneri*, its distinguishing characters being the division of the stalk into arms, and the structure of the glebiferous layer.

Pharus, gen. nov. Receptaculum stalked: stalk dividing above into arms which normally unite at the apex: glebiferous layer borne solely on the arms, and consisting of numerous plicate processes and plates, perpendicular to the arm, closely packed together, and presenting a granular outer surface, similar to that of Clautriavia.

Pharus Gardneri (Berk.). *Lysurus Gardneri* Berk., in Hooker's Lond. Jour. Bot. v. (1846) p. 535 and vi. (1847) p. 512. *Lysurus* (*Desmaturus*) *Gardneri* Schlecht., in Linnaea, 31 (1861–62), p. 180. *Colus Gardneri* (Berk.) Ed. Fischer, Vers. e. Syst. Uebers. p. 77 (1886), and Sacc., Sylloge, vii. p. 21. *Lysurus Gardneri* Berk., of Lloyd, Synopsis of the known Phalloids. Not *Lysurus Gardneri* Berk., of Cleland and Cheel, Notes on Australian Fungi, No. 2, Jour. Proc. Roy. Soc. N.S.W., xlix. p. 204; li. p. 364.

Hab. Ceylon only.

EXPLANATION OF PLATE V.

Fig.

1. *Pharus Gardneri*, natural size. Specimen with five arms, united at the apex. The gleba has been removed as far as possible, but traces remain between the ends of the processes and give the glebiferous layer a dark appearance.
2. *Pharus Gardneri*, upper part, natural size. Specimen with six arms, the junction of the arms produced into an apical appendage. This abnormality has been met with only once.
3. *Pharus Gardneri*. An arm viewed from the inner side, after removal of the gleba. × 4.
4. *Pharus Gardneri*. Cross section of an arm through the glebiferous region. × 4. The furrow is on the outer side of the arm.
5. *Pharus Gardneri*. Cross section of the egg, through the region of the arms, slightly enlarged. The separate gleba masses surround the arms almost completely, being interrupted only by the umbilical plates which are united to the arms along the dorsal furrow.

Fig.

6. *Lysurus australiensis.* Copy of Brittlebank's figure in Lloyd (loc. cit.). Note the continuation of the glebiferous layer from arm to arm, and the constriction of the stalk (represented by the double line) below the head.
7. *Lysurus australiensis.* The lateral surface of an arm. × 4.
8. *Lysurus australiensis.* Cross section of an arm. × 4.

NEW BRITISH FUNGI.

By E. M. Wakefield, F.L.S.

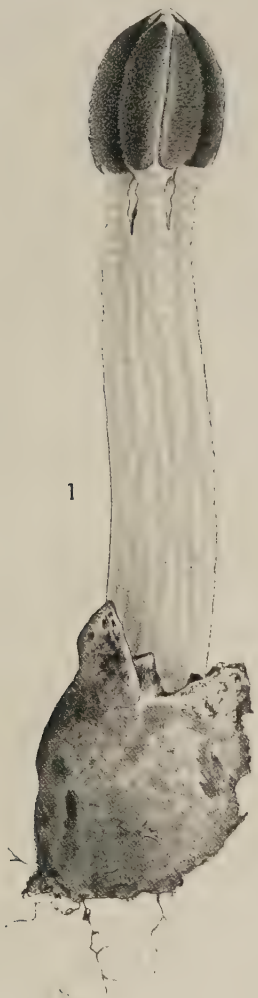
Hypochnus umbrinus (Fr.) Quél., Flore Myc. 1888, p. 2.

Thelephora umbrina Fr., Elench. Fung. i, 1823, p. 199; non *T. umbrina* A. & S., Consp. Fung. 1805, p. 281; *Corticium umbrinum* Fr., Hym. Eur. 1874, p. 658; *Thelephora biennis* Fr., Hym. Eur. p. 636, non Syst. Myc. i, p. 449; *Hypochnus tristis* Karst. in Soc. pro Faun. et Flor. Fenn. Med. ix, 1883, p. 71; *Hypochnopsis fuscata* Karst., Finl. Basidsv. 1889, p. 443; *Hypochnus fuscatus* Karst. in Sacc. Syll. ix, p. 244; *Tomentella tristis* von Hoehn. & Litsch. in K. Akad. Wiss. Wien, Sitzungsber. cxv, 1906, p. 1572; *Hypochnus sitnensis* Bres. in I. R. Accad. Agiati Atti, iii, 3, 1897, p. 115.

Effused, thick, soft, separable. Hymenium compact, membranaceous, brown with more or less of a vinaceous tint (varying from drab or deep brownish drab to dusky drab or Chaetura drab of Ridgway). Subiculum villose, warm sepia in colour. Hyphae brown, thick-walled, frequently septate, without clamp-connections, 4–5 μ in diameter. Basidia clavate, brownish, with four sterigmata. Spores dark brown, globose or subglobose, coarsely warted, 7–8 μ in diameter or 6–8 μ × 6–7 μ.

Hab. On rotten wood, Escrick, Yorks. Coll. Miss A. Lorrain Smith, Sept. 1918; on fallen twigs, leaves, etc., Weybridge, E.M.W. and A.A.P., Nov. 1918.

Readily distinguished by the dark, compact hymenium, the rather rigid hyphae without clamp-connections, and the



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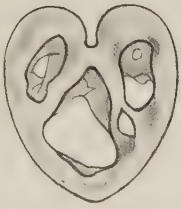


8

T. Petch del.

coarsely tuberculate spores. A solution of potassium hydrate dissolves some of the colouring matter from the sections. The specimen agrees with an authentic specimen from Fries in the Kew Herbarium.

Hypochnus isabellinus Fr., Obs. Myc. ii, 1818, p. 281.
Corticium isabellinum Fr., Hym. Eur. 1874, p. 660.
Hypochnus argillaceus Karst., in Soc. pro Faun. et Flor. Fenn. Med. vi, 1881, p. 13.

Effused, thin, following the inequalities of the matrix, inseparable, tomentose, pale Isabella colour (of Ridgway). Hymenium loose, pulverulent. Hyphae pale isabelline, branched at right angles, septate, without clamp-connections, 10–14μ in diameter. Basidia with four sterigmata. Spores isabelline, globose, aculeate, with fairly long spines (2–2·5μ), spore-body 7–9μ in diameter.

Hab. On the inner side of decaying bark, Staynor Wood, near Selby, Sept. 1918.

Among the hitherto recorded British species of Hypochnus this one is easily distinguished by its isabelline colour. An American species, *H. pannosus* Burt (= *Zygodesmus pannosus* Berk. & Curt.) resembles it in habit and colour, but is distinguished by the smaller hyphae with clamp-connections.

Galactinia Howsei Boud., Discomyc. d'Eur., 1907, p. 48.
Peziza Howsei Boud., in Bull. Soc. Bot. Fr., xxvi, 1879, p. lxxv, tab. 3, fig. 3; Bres., Fung. Trid. i, p. 91, tab. 103.

Ascophore sessile, cup-shaped, 3 cm. wide, whitish-tomentose at the base, smooth or slightly furfuraceous towards the margin; hymenium violet, tinged with yellow. Paraphyses septate, slightly clavate, 5–6μ wide above, contents guttulate, more or less tinged violet. Asci cylindrical, 8-spored, apex operculate and becoming blue with iodine, 200–300μ × 12–14μ. Spores almost hyaline or slightly tinted yellowish, narrowly oblong-elliptic, epispore granular, 20–22μ × 8–9μ, 2-guttulate.

Hab. On the ground, Byram Park, Yorks. Coll. C. Rea, Sept. 1918.

This species closely resembles *G. ampelina* Boud. and *G. praetervisa* (Bres.) Boud. in colour, but is distinguished from both by its spores. In *G. ampelina* the spores are smooth, while in *G. praetervisa* they are considerably smaller than in the present species. The spore-size in the present specimen is slightly greater than that given in the original description (17–19μ × 7–8μ).

Helotium ciliatosporum Boud., Discomyc. d'Eur., p. 114.
Belonioscypha ciliatospora Rehm, in Rabenh. Krypt. Flor. I, Abt. iii, p. 744; ? *Ciboria ciliatospora* Fuck., Symb. Myc. p. 311.

Apothecia stalked, ochraceous, gregarious, 1–3 mm. high. Disk 1–2 mm. in diameter, at length plane, with a distinct involute margin, externally slightly paler, with minute adpressed longitudinal fibrils. Stalk slender, pale yellow, smooth or slightly strigose, 1–2 mm. in length. Asci elongated, clavate, 135–150μ × 10–12μ. Spores somewhat "torpedo" shaped (pointed at each end, but more distinctly narrowed towards the base), with a short cilium, 5μ long, at one or both ends, 20–27μ × 4–5μ without cilia. Paraphyses filiform, unbranched, not at all or only slightly thickened towards the apex.

Hab. On the vascular skeleton of a herbaceous stem, Weybridge, A. A. Pearson, Oct. 19, 1918.

The Weybridge specimens are evidently the same species as the plant described by Rehm. As pointed out by the latter, however, this plant differs somewhat from that originally described by Fuckel. The latter gives the size as up to one inch high, and states that the margin is not distinct, whereas in these specimens there is always a distinct, erect or involute margin.

Gloeosporium inconspicuum Cav., Fung. Longobard. Exs. v, No. 249; Sacc. Syll. xiv, p. 1010.

Spots large, more or less circular, but without a definite margin, yellow to brown. Acervuli exceedingly minute, scarcely visible even with a lens, developing beneath the epidermis. Conidiophores hyaline, crowded, filiform, springing from a thin basal stratum. Conidia minute, bacilliform, hyaline, 1–2μ long.

Hab. On fading leaves of elm, Southampton, J. F. Rayner, Oct. 1918.

Ramularia Barbaraeae Peck, in 40th Ann. Rep. State Mus. New York, 1888, p. 63.

Spots rounded, white, becoming dry and thin, with a definite margin. Acervuli amphigenous, white, forming a fairly compact felted layer over the whole surface of the spores. Conidiophores fasciculate, simple or slightly branched, up to 70μ long, 4μ thick. Conidia hyaline, cylindrical, unseptate, 18–20 (–30)μ × 3–4μ.

Hab. On living leaves of *Barbaraea vulgaris*, Bungay, Col. C. Theodore Green, Jan. 1919.

A NEW MYCENA.

By A. A. Pearson, F.L.S.

MYCENA EPIPTERYGIOIDES n.s.

Macroscopic features. Cap membranaceous, greenish yellow, depressed in centre, which is usually a little darker; persistently hemispherical, striate or sulcate, edge sometimes crenate, pellicle separable, viscid, average dia. 10 to 15 mm. sometimes much larger. Gills white at first, then a delicate greenish yellow, adnate with a decurrent tooth, rather distant, alternate long and short. Stem cylindrical or compressed, viscid, hollow, greenish, usually with reddish stains at base. Average length about 6 cm., dia. about 2 mm. Spore print white.

Microscopic characters. Basidia about $30 \times 6\frac{1}{2}\mu$ with two sterigmata only which are very prominent. Spores hyaline, broadly elliptical $9–10 \times 7\frac{1}{2}–8\mu$, contents granular. Gill edge with finely ciliated brush-like cystidia; on gill face there are no cystidia.

Habitat. In damp places among moss in pine woods. Common in late autumn in the pine woods of Oxshott and St. George's Hill, Surrey. Usually growing in groups, but not fasciculate.

Doubtless this common species is familiar to many mycologists, who may have listed it as a green variety of *Mycena epipterygia* (Scop.) Fr., to which it is closely related. It will, however, be found quite distinct in many features. The microscopic characters are especially interesting. At first it seemed that the cystidia might be due to the puckering of the viscid thread on the gill edge. This edge can easily be removed with a needle, and then there are no cystidia visible, the 2-spored basidia being clearly defined on what might be thought to be the real gill edge. Specimens were submitted to Miss

Mycena epipterygioides. Basidia, spores, and cells from removable edge of gill.

E. M. Wakefield, and she found on examining the viscid thread by itself that the cystidia did exist, and were clearly seen springing from the loosely woven hyphae of which the viscid thread is composed. The brush-like sculpturing was especially distinct when the preparations were stained with methylene blue. We are much indebted to her for this observation and for the accompanying figure.

Latin diagnosis. Mycena epipterygioides Pearson. Hygrophana. Pileo 1–2 cm. lato. hemisphaerico, membranaceo, viridi-citrino, disco obscuriore et depresso striato vel sulcato, margine saepe crenato, pellicula secernibili viscida tecto. Lamellis ex albido citrinescentibus, adnatis, dente decurrentibus, sub-distantibus. Stipite aequali, fistuloso 5–8 × 0·1–0·2 cm. viscido, citrino, basi rufescente. Sporis in cumulo albis breviter ellipsoideis 9–10 × $7\frac{1}{2}$–8μ hyalinis levibus. Basidiis 2-sporis fere 30 × $6\frac{1}{2}\mu$. In margine cystidiis globosis cum pilis tenuibus. Habitat in pinetis locis humidis inter muscos.

ADDITIONAL RESUPINATE HYMENOMYCETES FROM THE WEYBRIDGE DISTRICT.

By E. M. Wakefield, F.L.S., and A. A. Pearson, F.L.S.

In the last number of these transactions we gave a list of resupinate Basidiomycetes found in the neighbourhood of Weybridge. The list, which represented the results of field work during the winter of 1917–18, included fifty-two species.

The work was continued the following winter and we are able to make many interesting additions. Some of these were found before, but could not be determined to our satisfaction. It is perhaps needless to say that every specimen we have handled has not been given a name. A good deal of work remains to be done before the possibilities of this richly wooded neighbourhood are exhausted—if indeed such a term should ever be used when we are dealing with so protean a subject as mycology. Most of the species recorded in the first list reappeared the next year. Many were found throughout the

autumn and winter, but others shew a decided preference for the later months of the year. For instance, we did not meet with *Peniophora pallidula* before late November and December, when it cropped up everywhere.

The species which appeared with the greatest frequency were the following:

Corticium laeve (Pers.) Quél., *Sambuci* (Pers.) Fr., *arachnoideum* Berk., *botryosum* Bres., *subcoronatum* von Höhnel et Litsch., *confluens* Fr., *sulphureum* (Pers.) Bres., *echinosporum* Ellis (pink form), *comedens* Fr., *praetermissum* (Karst.) Bres.

Peniophora pallidula Bres., *cremea* Bres., *velutina* (DC.) Cooke, *setigera* (Fr.) Bres., *gigantea* (Fr.) Mass., *cinerea* (Fr.) Cooke, *quercina* (Pers.) Cooke.

Hypochnus fuscus (Pers.) Karst., *roseo-griseus* Wakef. et Pearson.

Coniophora puteana Fr., *arida* Fr.

Stereum rugosum (Pers.) Fr., *sanguinolentem* (A. & S.) Fr., *hirsutum* Fr., *purpureum* (Pers.) Fr.

Odontia farinacea (Pers.) Quél.

Caldesiella ferruginosa (Fr.) Sacc.

Merulius tremellosus (Schrad.) Fr.

Phlebia merismoides Fr.

Irpex obliquus (Schrad.) Fr.

The soil in this neighbourhood is mostly gravel and sand. There are extensive pine woods, a good sprinkling of oak, birch and sweet chestnut; also a little beech. We shall hope later to be in a position to compare this list of common species with a similar list for other soils.

An observation which may again be brought forward relates to the genus *Radulum*. Numerous specimens were gathered and some could be connected with known species of other genera. *Corticium bombycinum* shewed gradations from a smooth typical *Corticium* to a well-defined blunt-toothed Raduloid form. A cream coloured *Radulum* grew near the common *Merulius tremellosus* and was found to have an identical spore. It was growing on birch, which is the favourite habitat of this species, and was probably only an abnormal form.

Radulum molare Fr. (*R. membranaceum* Bres.) appears to be a form of *Corticium confluens*. Raduloid forms have been recorded of other species of *Corticium*, etc., and similar relations may be found to exist between many forms hitherto recorded as separate entities.

This variability is a common enough feature in many groups of fungi and renders all the more important the study of their microscopic features, which would seem, on the whole, to be constant. The spore is a most valuable indication, but it is necessary to point out that the spore alone is rarely sufficient, and must be taken in conjunction with other characters.

The following species now have to be added to the list given in the last Transactions:

PLATYGLOEA Schroet.

Receptacle homogeneous, waxy, gelatinous, or coriaceous gelatinous, effused, or more or less rugulose. Hymenium continuous. Basidia cylindrical, erect, transversely septate, sterigmata long. Spores uncoloured, smooth, obtuse or apiculate, straight or curved, producing sporidiola on germination. Growing on wood.

Platygloea effusa Schroet., Pilz. Schles. I, p. 384.

×550

Platygloea effusa.

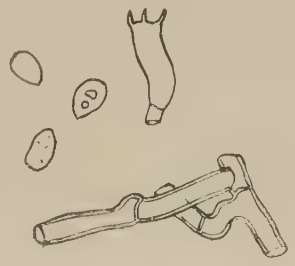
Effused, thin, somewhat gelatinous but firm and greyish when fresh, when dry whitish, closely adherent, hymenium pulverulent under the lens. Basidia elongated, cylindrical, wavy, apex frequently incurved and almost circinate, transversely 4-septate, 40–50 × 4–5μ. Spores hyaline, smooth, elliptical or ovate, with oblique apiculus, 7–8 (–10) × 4–5μ. Subhymenial hyphae fine, guttulate, 1–2μ in diameter, arising erect and parallel from a compact, pseudoparenchymatous basal stratum, made up of broader (4–5μ) hyphae.

On bark of a fallen branch, St. George's College, Weybridge, June, 1918, A.A.P. The habit of this plant is like that of a *Corticium* or *Sebacina*, but the transversely septate basidia at once distinguish it when looked at under the microscope.

Corticium bombycinum (Sommerf.) Bres., Hymen. Hung. Kmet. p. 47. *Thelephora bombycina* Sommerf., Flor. Lapp. Suppl. p. 284.

Irregularly effused, thick, soft, rather separable, often assuming hydnoid forms, margin and subiculum floccose.

Hymenium when perfect waxy, at first white then deep cream or pale alutaceous, pulverulent under the lens. Basidia cylindrical to clavate, with four sterigmata. Spores hyaline, smooth, elliptical or ovate, somewhat irregular; 9–12 × 6–8μ, guttulate. Hyphae rather thick-walled, branched, frequently septate, with clamp-connections, 4–6μ in diameter.



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Corticium bombycinum.

On living pollarded willow, St. George's College, Weybridge, Nov. 1918, A.A.P. and Rev. P. Alexander; on heads of willow, near Worcester, Nov. 1918, C. Rea; on a stump (not named), Marston Green, near Birmingham, Nov. 1918, W. B. Grove.

This species would appear to have a preference for living trees, as it is recorded by Bourdot also on living trunks of various trees. There is however at present no evidence that it is a parasite. Raduloid forms occur frequently intermixed with the typical *Corticium* form. The soft, thick texture and large, somewhat irregular spores are characteristic of the species.

Corticium Sambuci Fr., *vellereum* Ell. & Cragin, *echinosporum* Ellis (yellow form), *confine* Bourd. & Galz.

Corticium atro-virens Fr., Epicr. p. 562.

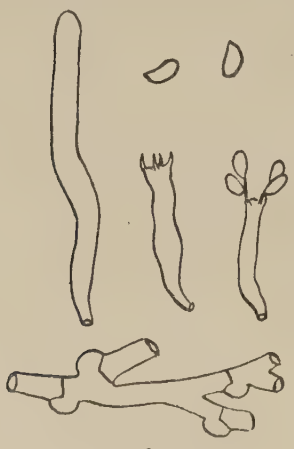
The spores of this specimen are regularly globose, 5μ in diameter, hence slightly larger than those described by Bourdot (3–4 × 3–3·5μ) and figured by Rea (Trans. Brit. Myc. Soc. III, Plate 16). Hyphae, basidia and spores are all pale grey-blue by transmitted light. The colour of the fungus when fresh is in Ridgway's nomenclature "Deep bluish gray-green" to "Russian green."

On dead leaves and twigs lying on the ground, Weybridge, Nov. 1918, A.A.P. & E.M.W. In habit suggesting a Hyphomycete.

Corticium (*Glococystidium*) *coroniferum* von Hoehn. et Litsch. in Sitzungsber. K. Akad. Wiss. Wien, CXVI, 1907, p. 825.

Effused, pure white then cream, very thin, following the inequalities of the matrix, fragile and pulverulent, easily separable as a delicate pellicle; margin indeterminate, gradually thinning out to a cobweb-like film. Glococystidia rare, sometimes lacking, cylindrical, obtuse, very thin-walled, 45–50 × 5–6μ, contents more or less yellowish. Basidia cylindric-

clavate, wavy, 3·5–4μ wide, when mature elongated and projecting from the hymenium, apex truncate, sterigmata 4–8, in British specimens usually 4, rather long. Spores narrowly elliptical, with oblique basal apiculus, variable in size, 4·5–6 (–8) × 2–3 (–5)μ. Basal hyphae frequently septate, with clamp-connections, 4–5μ in diameter.



× 850

Corticium coroniferum.

On bark and rotten wood, and often spreading on to the surrounding soil, etc., Kew, Jan. 1911 (E.M.W.); Cusworth, near Doncaster, Sept. 1914 (E.M.W.); Weybridge, Dec. 1917 (A.A.P.).

In this species the walls of all the elements are very thin and delicate, so that it is difficult to observe the structure from dried specimens. The gloeocystidia are sometimes lacking, hence the species might be looked for amongst white Corticia of the section Urnigera. The peculiar basidium which is found in *C. coroniferum* is characteristic of the section Urnigera (see Bourdot in Bull. Soc. Myc. Fr. 1911, p. 243), and in fact this species forms a connecting link with that group. The shape of the mature basidium is most easily described as like that of an extended *Hydra*.

×850

Peniophora accedens.

Corticium lactescens Berk.

Peniophora pubera (Fr.) Sacc., *glebulosa* Bres. (type form), *longispora* (Pat.) von Hoehn.

Peniophora accedens Bourd. et Galz., in Bull. Soc. Myc. Fr. XXVIII, 1912, p. 386.

Very thin, effused, greyish-white, becoming cracked on drying; hymenium glistening with the cystidia when viewed with a lens. Cystidia of similar type to those of *P. glebulosa*, smooth and thick-walled except at the apex, but here the apex is swollen into a globose head, about 10–11μ in diameter. Hyphae indistinct, 1·5–2μ in diameter. Basidia 4-spored, 5μ wide. Spores elliptical, with lateral apiculus, 4·5 (–5) × 3μ.

On wet, rotten, decorticated branch, Weybridge, Nov. 1918, A.A.P.

Distinguished from *P. glebulosa* by the capitate cystidia and the different spores. It appears to be sufficiently distinct to be regarded as a separate species.

Hypochnus zygodesmoides (Ell.) Burt, *umbrinus* (Fr.) Burt*, *ferrugineus* (Pers.) Fr.

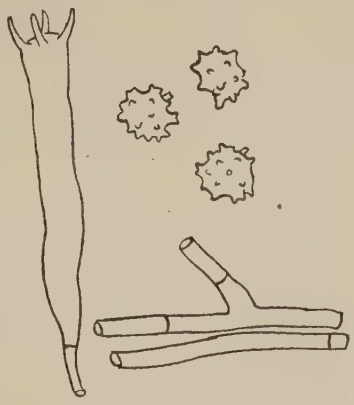
Hypochnus roseo-griseus Wakef. et Pearson, sp. nov.

Fungus effusus, mollis, tenuis, pelliculosus vel membranaceus, facile secedens, ambitu subradiato griseo, hymenio pulverulento, pallide griseo-vinaceo. Hyphae subhymeniales subhyalinae; hyphae basales dilute griseae, vix ramosae, septatae, non nodosae, 2·5–3μ diametro.

Basidia clavata, subhyalina, 40–55 × 7–10μ; sterigmata 2–4, 7–9μ longae. Sporae angulato-subglobosae, hyalinae vel pallide stramineae, crasse verrucosae, 7–9μ diametro, saepe 1-guttulatae.

Hab. On bark, wood, etc., especially of pine, Weybridge, 1917–18, A.A.P.

This is the commonest *Hypochnus* in the pine woods of this district, and is especially abundant on old pine roots.



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Hypochnus roseo-griseus.

The colour of old specimens recalls that of *H. fuscus*, but is paler, with a greyish bloom. When fresh it is between "light vinaceous fawn" and "cinnamon drab" of Ridgway, with a paler, "drab-grey" margin. Young specimens are greyish-white to dirty buff. The species is marked off from all other species of *Hypochnus* with which it might otherwise be confused by the very fine hyphae, without clamp-connections. The almost hyaline spores at once distinguish it from *H. fuscus*.

Grandinia helvetica (Pers.) Fr.

Odontia fusco-atra (Fr.) Bres.

Radulum laetum Fr. Apparently a form of *Peniophora incarnata*.

* See p. 132

Radulum mucidum Bourd. et Galz., in Bull. Soc. Myc. Fr. XXX, 1914, p. 247.

Hydnum mucidum Pers. sensu Bres., Fung. Hung. Kmet., non *H. mucidum* Fr.

Effused, soft, separable, yellow, more or less nodular, teeth short, scattered, awl-shaped, or when growing on an upright surface taking on elongated forms. Basidia clavate, 7μ wide, with 4 sterigmata. Spores elliptical to subglobose, with a lateral apiculus, 4–5 × 3·5–4μ, very pale yellow, 1-guttulate. Hyphae thin-walled, frequently septate, with clamp-connections, 4–7μ in diameter.

Inside a hollow stump, extending for some distance over bark and living stems of ivy, St. George's College, Weybridge, Nov. 1918, A. A. P. and Rev. P. Alexander.

Easily distinguished by the small subglobose spores. As the Weybridge specimen was more distinctly yellow than is indicated in the description given by Bourdot (loc. cit.), material was sent to him for confirmation. He states that he had also received from Mr. Romell a specimen which was said to be "pale sulphur or straw-coloured" when fresh. He had only once seen it fresh himself, and thinks the yellow colour may be fugacious.

It seems very doubtful whether this is Persoon's *Hydnum mucidum*, as Bresadola believes. Persoon describes his plant as pure white, and does not mention any variation to yellow.

Radulum molare Fr., Elenchus I, 1828, p. 151. *Radulum membranaceum* (Bull.) Bres., Fung. Hung. Kmet. p. 39.

An irregular form growing on a fallen branch was identified for us by M. Bourdot as a "forme tomenteuse" of this species. In texture, colour and in the large broadly elliptical spores *R. molare* resembles *Corticium confluens*, of which it may be a form. The hyphae, however, are slightly larger and more distinct. Bresadola considers this to be the true *Hydnum membranaceum* of Bulliard, and not the brown species to which Fries attached the name.

Merulius pinastri (Fr.) Burt.

On decaying sticks in the grounds of St. George's College, Weybridge, A. A. P.

This species was recorded in the Kew Bulletin, No. 7, 1918, p. 230.

Merulius tremellosus (Schrad.) Fr.

Solenia poriaeformis Fuck., Symb. Myc., Nachtr. I, 1871, p. 2. *Peziza poriaeformis* (DC.) Fr., Syst. Myc. II, p. 106.

Cups minute, very crowded, forming a compact, effused layer, the whole having the appearance of a grey *Poria*, the separate cups scarcely visible to the naked eye. Each cup about 5 mm. in diameter, externally whitish or tinged ochraceous, minutely hairy, hymenium grey. Basidia clavate, 20–25 × 6–7μ. Spores subglobose, 5–6 × 4–4·5μ.

On rotten wood, Weybridge, Sept. 1918, Rev. P. Alexander, O.J.

The minute, crowded, greyish cups, and the globose spores distinguish this from the other British species of Solenia.

Solenia anomala Fr.

Poria hymenocystis Berk. et Br.

OBSERVATIONS ON THE FUNGI OF THE LANCASHIRE AND CHESHIRE SAND-DUNES.

By Harold J. Wheldon, F.C.I.S.

The vegetation of the sand-dunes presents a remarkable range of species of fungi for the study of systematists and biologists and to both affords unique problems, and as I have had the opportunity of observing the fungi of the dunes on the coast of Lancashire and Cheshire during a period of about seven years I thought some account of them would be of further interest as affording additional information to, and for comparison with, the observations made by Miss Wakefield* last year on the dune fungi of the Gower Coast, South Wales.

The dunes referred to border the Wirrall Coast in Cheshire between the estuaries of the Dee and Mersey, and in Lancashire extend from the mouth of the Mersey, at Seaforth, to Southport, continuing again on the north side of the Ribble estuary from Lytham and St. Annes to Blackpool.

The Wirrall dunes, once damp and supporting a paludal vegetation in the hollows, either have been drained with the encroachment of verdant golf courses and urban extensions,

* Brit. Myc. Transactions, VI. (i), p. 33, 1917.

or in places have been filled up above the level of the water-table by inward drifts of fresh sand-deposits with a result that many of those rare treasures prized by botanists have succumbed. The same thing has happened to even a greater extent at Lytham and St. Annes, but happily those in South Lancashire have been spared this fate.

The Lancashire sand-dunes are the most extensive on the English coast, having a depth of nearly four miles at Formby, and they constitute a remarkable example of active dune formation, whilst to mycologists they present unique associations of fungi.

To appreciate properly the extraordinary conditions prevailing it is necessary to explain that, because the sea is receding here, these dunes are still in process of formation, and that there are three distinct ranges of dunes, between which lie rather wide flat hollows, or "slacks," which are damp, and in places swampy. The third range of sand-dunes has been planted extensively in places with young conifers, interspersed with various deciduous trees, such as Alnus, Populus, Betula, Hippophae and several species of Salix.

It would seem impossible, one would think, for fungi to develop on the loose blown sand above the line of tidal drift and on the first barren tract of dunes, yet here specimens of *Volvaria speciosa* are not infrequently found partially buried, and occasionally *Volvaria gloiocephala*, although the latter prefers the inner grass-grown parts. Similarly, growing in the bare sand near the shore at Wallasey, the late Dr. Ellis found *Geoglossum glabrum* (Pers.) several years in succession. The only other species found in the loose sand nearest the sea are *Tubaria furfuracea* var. *trigonophylla* and *Marasmius graminum*, and in these instances it has been found that the mycelial threads sprang from buried leaves and stems of the grasses *Agropyron junceum* or *Ammophila arenaria*; although the *Tubaria* often proved to be growing from buried pieces of drift wood and debris washed up by the tide. Further nutrition would be afforded by the many remains of minute algae which the sands contain in this zone.

On the slopes of the loose sandhills which face inland occurs that curious stalked Gasteromycete, *Tulostoma mammosa* accompanied by scattered specimens of *Inocybe rimosa* and others of this genus and less commonly by *Naucoria arvalis*, but these are found only with difficulty, being almost completely buried. I am of opinion that the roots and buried remains of *Agropyron* and *Ammophila* provide the means of sustenance.

Behind the outer sandhills lies the first wide, flat valley

or "dune slack" extending for several miles parallel with the sea. It is apparently in a transitional stage to a fixed dune association, being more stable and richer in humus. It is carpeted with many rare byrophytes amongst which occur here and there several species of *Carex, Erythraea, Juncus* and some grasses, such as *Agrostis vulgaris*. The old *Brya* capsules become infested with *Phoma muscicola* A. L. Sm., and the carpet of mosses is broken by extensive greyish white patches of the lichen *Arthopyrenia areniseda* A. L. Sm., this being the original station in which Mr. J. A. Wheldon found both these species. Here occur troops of the very interesting discomycetes *Cyathipodia corium* (Weberb.) Boud., *Galactinia brunneoatra* (Desm.) Boud., *Pseudoplectania nigrella* (Pers.) Fck. and *Ciliaria trechispora* var. *paludicola* Boud., and it is not unusual to find great numbers of these four growing in close proximity, sustenance and moisture for them being maintained by the mosses, hepatics and algae amongst which they grow. *Sepultaria arenicola* (Lév.) Mass., which is plentiful here, is entirely buried in the sand whilst young and spherical, and it is not until the cup commences to open, its margin throwing back the covering sand, that the presence of the fungus is apparent. At first glance it conveys the idea of holes made by a walking stick or umbrella. These remarks also apply to the rather larger *Sepultaria sepulta* (Fr.) Mass., although the disk of this becomes more exposed than in *S. arenicola*. With both these species there is usually a large mass of mycelial threads binding together a large ball of sand, and in many cases they do not appear to depend upon other plants for nutrition, but occasionally when near *Ammophila* the mycelium has been found attached firmly to its roots; probably also they find sustenance in the numerous decaying underground stems and buried decomposing leaves of dwarf willow (*Salix repens*), or even from decaying nostoc, diatoms, etc., which abound in the damp sand. Dr. Ellis records *Melanospora zobelii* (Corda) Fck. on *S. arenicola*, and on this and *S. sepulta* there frequently appears another species, *Sphaeroderma sepultariae* Wheldon. Here in the spring *Gyromitra esculenta* sometimes appears in confined areas in troops or singly, and later in the year *Inocybe rimosa* and *Psilocybe ammophila* are frequent, the latter principally after rain in summer. The mycelial threads of these can be traced to the *Ammophila*. *Geaster striatus* DC. and *Geaster Bryantii* Berk. occur here occasionally, and on the Wallasey coast Higgins recorded *Battarrea phalloides* Pers. as growing on a bare sandy bank, but neither the late Dr. Ellis nor I have met with this treasure. It is a striking fact that there is a great preponderance of brown spored fungi on the open dunes principally

represented by *Hebeloma, Inocybe, Cortinarius, Tubaria* and several Gasteromycetes.

The genus *Inocybe* is particularly prevalent on the sand-dunes, especially in the hollows clothed with *Salix repens,* and the long mycelial threads ramify among the roots of the *Salix* and grasses in the vicinity. It should be noticed that the underground stems and roots of the dwarf willow are densely packed beneath the surface and, as they decay, afford unlimited food for saprophytic fungi. The dominant species are *Inocybe rimosa, I. eutheles* and *I. dulcamara* which are plentiful during a long season, and other species not infrequently met with are *I. scaber* Mull., *I. mutica* Fr., *I. cervicolor, I. asterospora,* and *I. duriuscula* Rea. Specimens of the last-named were submitted to Mr. Rea for confirmation by our late friend Dr. Ellis. In September and October *Armillaria ramentacea* occurs in considerable abundance in association with the dwarf willow.

In similar places *Cortinarius* (*Myxacium*) *collinitus* is also very frequent, and less commonly *Cortinarius* (*Dermocybe*) *caninus, C.* (*Telamonia*) *hinnulius, C.* (*Tel.*) *limonius, C.* (*Tel.*) *lucorum, C.* (*Tel.*) *rigidus* and *C.* (*Tel.*) *injucundus.* In late summer *Hebeloma mesophaeum* var. *minor* Cke. appears in great troops in the flats between the sandhill ranges, and in fact it is in these moist *Salix*-covered slacks that fungi are most frequent, and the majority of those already mentioned occur in them. In the spring time, about May, *Verpa digitaliformis* may be found in damp places among the dwarf willow, and our member Miss Blackwell informs me that she has traced the mycelium to the roots of *Luzula* and *Salix repens. Morchella esculenta* occurs, but rather sporadically.

Further inland the dunes are better clothed with more mixed vegetation in which *Pyrola, Parnassia* and Orchids are conspicuous, and in places large areas covered with the creeping *Rubus caesius.* Here we find a greater variety of fungi. Uredinales are numerous, especially interesting being *Ustilago hypodytes* on *Elymus arenarius,* and the Caeoma stage of *Melampsora Orchidi-repentis* on several kinds of orchid especially *Orchis incarnata* and *Listera ovata;* but in spite of the abundance of *Parnassia* I have never found *Uromyces* on its leaves, although at Mr. W. B. Grove's suggestion I have searched frequently for it. The following agarics make their appearance here in addition to those already mentioned: *Clitocybe dealbata, C. aggregata, C. cricetorum, Hygrophorus conicus* and several other common species of this genus, *Tricholoma nudum, Lepiota cristata, Entoloma sericeum, Entoloma nigrocinnamomeum, Clitopolus prunulus, Bolbitius fragilis, B. tener, Galera rubiginosa, Hebeloma mesophaeum, H. strophosum.* The "puff-

balls" are well represented, often in considerable abundance, by *Lycoperdon caelatum, L. perlatum, L. Cookei, Bovista plumbea* and *B. cepaeformis*. On the golf links there is an abundance of *Marasmius oreades*. Miss E. M. Blackwell has sent me *Lepiota erminea* and *Armillaria haematites* from this locality.

I have mentioned that the inner dunes have been extensively planted with conifers, and I feel I cannot conclude without referring to the most interesting variety of fungi which has been introduced with these trees, particularly those species usually confined to old-established pine woods. It is remarkable to find so many fungi which are usually associated with pine woods thriving in such abundance in so unexpected a locality. In view of the meagre nourishment there must be in the loose sand in which they grow, one can come to no other conclusion than that sustenance is provided by buried pine needles, cones and twigs, and possibly in some cases the mycelial hyphae absorb nutrition from the root-fibres of the trees. Also, it must not be overlooked that the enormous quantity of pollen shed by the conifers must contribute considerably to the food supply of the fungi. It would be an interesting work to investigate and record the fungi occurring in the numerous recognised plant associations. In this direction it is noteworthy that if the fungi occurring in the young conifer plantations on the sand-dunes be compared with those of established pine woods, the similarity of species is strikingly apparent, and when it is considered that before the conifers were planted in this locality, the dunes were practically devoid of vegetation, the entity of the pine wood association would appear to be demonstrated practically. The following fungi appear in numbers: *Lepiota procera, Armillaria ramentacea, Collybia conigena, C. tenacella, Gomphidius viscidus, Gomphidius gracilis, Tricholoma terreum, Paxillus lepista, Russula purpurea, R. integra, Lactarius vellereus, L. deliciosus, L. piperatus, L. torminosus, L. controversus, Clitocybe fragrans, C. ditopus, C. cerrusata, Boletus flavus, Boletus badius* in addition to a number of discomycetes and pyrenomycetes on fallen twigs, cones and leaves. *Hydnum auriscalpium* is frequent on old cones.

Particularly interesting is the abundant growth of *Thelephora caryophyllea* in the loose sand about the roots of young sallows and other young shrubs especially where these have been cut down to the base, which is sometimes done to promote bushy growth. *Thelephora laciniata* is plentiful in the older pine plantations amongst the covering of fallen pine needles.

Generalising on the growth of fungi on the sand-dunes, naturally the most favourable places are the damp hollows dominated by *Salix repens* or the tree-planted areas, and here

fungi appear in great abundance during a long season extending throughout summer and autumn. The "Marram dunes" are the least productive but, as I have stated before, a number flourish well on these dry loose sand-hills. Existence on the latter is apparently only possible owing to the moisture and nutrition provided by the planted star grass (*Ammophila arenaria*), of which the roots frequently extend to a great depth in the sand in search of moisture, and also the stems constantly climb upwards to overcome burial in the mobile sand.

On the outermost hills, the fungi favour the slopes with orientation towards the land, and it would seem that they do not flourish well in the face of the direct sea winds although on the other hand in the sheltered hollows both fungi and lichens thrive in the pure atmosphere which exists there.

It is worthy of note also that the Inocybes which are so prevalent in the open dunes do not favour the parts planted with conifers to the same extent. The number of species in the Salix-dunes is really remarkable and the quantities even more so, equalling as they do those of old woodlands. The fungus association of the open dunes is quite distinct from that of the planted areas.

Considerable attention has been devoted to the Oecology of sand-dune plants, but the observations do not seem to have been extended to the fungi. My own work in this direction was interrupted before even the first preliminary floristic survey was completed, and no doubt many species remain to be discovered peculiar to such situations; these are sure to reward careful workers. A general survey of the fungus flora of the dune tracts having been obtained, it is hoped an attempt may be made to follow up the life-history of the numerous curious and interesting species which, at least in Lancashire, appear to be restricted to this formation.

As a preliminary to continuing investigations outlined above, I published in 1914 an account of "The Fungi of the Sand-dune Formation of the Lancashire Coast" in which were defined several distinct associations of plants occurring on the dunes, with special reference to the fungi occurring in them, and a list of species was also included. Unfortunately my own removal from the district and the regrettable death of Dr. Ellis suspended active work for a time, but we have recently welcomed new recruits to the Society who are now continuing the exploration of these dunes, and it is to be hoped their researches will provide matter of interest for some of our future meetings.

N.B. Water colour drawings of many of the fungi referred to were exhibited during the Foray.

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S.

Mr. J. Ramsbottom who usually shares in the preparation of the paper on Microfungi has until recently been engaged on R.A.M.C. work in Salonica and has therefore been unable to collaborate in the present contribution. Mr. W. B. Grove has been publishing lists of Sphaeropsideae (Phoma, Phomopsis, etc.) in preparation for a complete work on that group of British Fungi. In view of its early publication, it has not seemed to be necessary to publish here his new combinations, etc.

Thanks are cordially given to Miss Roper and others who have sent the records of new finds and especially to Mr. D. A. Boyd who has as usual contributed much interesting material.

PYRENOMYCETES.

Nectria magnusiana Rehm ex Sacc. in Mich. i. p. 294, 1878.

The conidial stage (*Tremella aurantiaca*) was found parasitic on the tubercles of *Diatrypella favacea*, on dead branches of *Betula alba*: Great Bear Park. Grove in Journ. Bot. lvi. p. 286, 1918.

Gnomonia Rosae Fuck. Sym. p. 122, 1869.

Perithecia thickly scattered over the underside of the leaves, covered by the epidermis, rather flat and round, about 300μ in diam., the beak slender, black, about 1 mm. long. Asci somewhat fusiform, tapering down to a narrow stalk, about 40–45μ long, 6–8μ thick, 8-spored; spores narrowly cylindrical about 18–20μ long, 1–2μ thick, not visibly septate, containing minute guttulae.

On decaying leaves of *Rosa tomentosa* and on petioles of *R. spinosissima*, Ardrossan and Stevenston, Ayrshire, and on leaves of *Fragaria vesca*, Largs, Ayrshire; D. A. Boyd, Feb. 1918.

Didymosphaeria conoidea Niessl in Oest. Bot. Zeitschr. 1875, p. 202.

Perithecia scattered, becoming free, rather large, conoid with a flat base, slightly depressed at the apex, shining-black, leathery, the ostiole papillate or conoid. Asci cylindrical, stalked, 8-spored,

60–79μ × 5–7μ; spores monostichous, obovate, 1-septate, slightly constricted, pale brown, 6–9μ × 5μ; paraphyses slender, simple.

On stems of the larger herbaceous plants. On dead stems of *Senecio saracenicus*, Kilwinning, Ayrshire; D. A. Boyd, Aug. 1917.

Mr. Boyd's plant corresponds exactly with the published description except in the ascus which has frequently a long stalk and measures up to 105μ in length. The same type of ascus is present in Krieger's specimen of "Fungi Saxonici."

Leptosphaeria galiorum Sacc. f. *Dipsaci*, Grove in Journ. Bot. lvi. p. 286 (pl. 550, fig. 2), 1918.

On dead stems of *Dipsacus sylvestris*, Salwarpe, near Droitwich, July.

Melogramma spiniferum de Not. Sferiac. Ital. p. 53, 1863.

Stromata generally numerous and crowded, hemispherical and cushion-like, 2–3 mm. wide, hard, horny-carbonaceous, rough, black. Perithecia mostly about 4 to 10 in each stroma, irregular, globose or flask-shaped, greyish-black, with more or less bent shortly projecting ostioles; asci cylindrical subclavate or subfusiform, sessile, 190–210μ × 17–18μ, 8-spored; spores cylindrical, rounded at the ends, slightly bent, 7-septate, brown, but the end cells hyaline, 54–70μ × 8μ; paraphyses delicate, sparsely septate, about 7μ thick.

On dead bark of *Fagus sylvatica*; D. A. Boyd, Stevenston, Ayrshire, March 1918.

In the specimen sent the spore cells are occupied by large guttulae.

MELOGRAMMA ELONGATUM n. sp.

Peritheciis subglobosis in stromata, elongata, angusta, congregatis vel solitariis, immersis vel prominulis, ca. 300μ lat., ad apicem poro pertusis; paraphysibus filiformibus; ascis elongatis, 8-sporis; sporis uniseriatis, oblongo-ellipsoideis, apiculatis, plerumque rectis, fuligineis, 18–30μ × 5–10μ, 2–3 (inaequaliter)—locularibus, cellulo hyalino minutissimo, ad unum vel utrinque extremum, praeditis.

In ramis putridis: C. McIntosh, Perthshire, 1893.

The stromata grow in parallel lines along the blackened wood. The species is distinguished chiefly by the very variable spore cells, usually unequally divided; from the longer cell a minute colourless cell is cut off; at the opposite end septation is less evident but there is usually present a colourless apiculus. Some of the spores are divided into three equal cells, one of the end cells being only faintly coloured.

Mycosphaerella Cydoniae Grove, in Journ. Bot. lvi. p. 285 (pl. 550, fig. 1), 1918.

On dead dry leaves of *Cydonia vulgaris*, on a heap of humus. Hereford, May, etc., 1917 and 1918. The genus name *Mycosphaerella* has been substituted for that of *Sphaerella* as the latter was originally that of a genus of green algae. Some authorities have limited *Mycosphaerella* to species with many-spored asci. Grove does not indicate the number of spores, presumably he accepts the broader interpretation of the genus.

Pleospora hydrophila Karst. in Hedwigia, xxii. p. 178, 1883.

Perithecia scattered, innate, spheroid, smooth, black, 0·2 mm. wide; ostiole papillate, emergent; asci oblong, subsessile, 80μ × 22μ, 8-spored; spores tristichous, oblong-fusiform, unequal-sided or slightly curved, 5-septate, slightly constricted at the septa, the third cell protuberant and with a longitudinal septum, yellow-brown, 22–30μ × 6–10μ.

On leaves of *Acorus calamus* in Fennica; on stems of *Alisma plantago-aquatica*, Kilwinning, Ayrshire: D. A. Boyd, Jan. 1914.

In Mr. Boyd's plant the perithecia are larger (350μ), the ostiole about 50μ across. The spores vary from monostichous to tristichous; coloration and size of asci and spores very similar.

Sphaerulina Alni n. sp.

Peritheciis laxe gregariis, nigris, sublentiformibus, ostiolatis, immersis, ostiolis epidermidem perrumpentibus, ca. 1 mm. diam.; ascis aparaphysatis, dense confertis, haud vel vix rosulatis, clavato-cylindraceis, rectis vel leniter curvatis, apice rotundatis, ad basim in stipitem ca. 15μ long. attenuatis; sporidiis inaequaliter distichiis, oblongo-ellipsoideis, rectis, vel interdum curvulis, 3-septatis, 22–30μ × 8μ, hyalinis, guttulatis.

In cortice suberoso emortui Alni: D. A. Boyd, West Kilbride, Ayrshire, April 1918.

Boydia gen. nov.

Perithecia nigro-brunnea, submersa, globoso-lenticularia, ostiolo breviter papillato pertusa. Ascis elongato-clavatis, octosporis aparaphysatis; sporis elongatis, curvulis, utrinque clavatis, medio sensim attenuatis, 1-septatis, hyalinis.

Evidently a member of the Sphaerellaceae, but unique in the peculiar spores.

B. remuliformis n. sp. Fig. 1.

Perithecia solitaria, numerosa, cortice subvelata, nigro-brunnea; contextu tenuiter membranacea, ca. 400μ diam.; ascis oblongis, ca. 155μ long., 25μ lat., apice rotundatis, basi

leniter attenuatis, sporis elongatis ca. 100μ long. in medio 3–4μ, apicem versus 7–8μ lat.

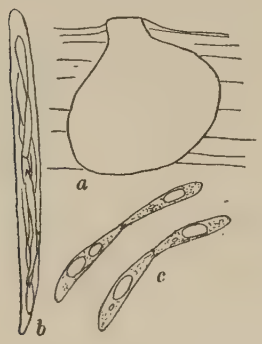

Fig. 1. *Boydia remuliformis* A. L. Sm.
a. Outline of perithecium. × 50.
b. Ascus (immature). × 270.
c. Spores. × 270.

In caulibus emortuis *Ilicis angustifoliae*, West Kilbride, Ayrshire: D. A. Boyd, Sept. 1918.

There is no discoloration of the twigs by the fungus but the internal tissues are permeated by a strong brown mycelium. The ostioles are prominent but are thinly covered by the epidermis which gives them a pruinose appearance.

Phyllachora Pastinacae Rostr. Plantepatalogie, p. 511; Cotton, in Kew Bull. 1918, p. 15.

The conidial stage (*Cylindrosporium*) was found attacking the parsnip in a market garden at Mickleton (Glos.).

HYSTERIACEAE.

Hypoderma Desmazieri Duby, Hyst. p. 42, 1862; Grove in Journ. Bot. lvi. p. 286, 1918.

On dead leaves of *Pinus Strobus*, Bagley Wood, Oxon., April (A. D. Cotton). Previously recorded from Crediton, Devon, in Trans. B.M.S. ii. p. 128, 1905.

Colpoma degenerans Mass. Fungus Flora, iv. p. 63, 1895.

Recorded by D. A. Boyd on dead branches of *Vaccinium uliginosum* from Glen Falloch, Perthshire, July 1907. The species is somewhat rare.

DISCOMYCETES.

Lachnea coprinaria var. *minima* Grove, in Journ. Bot. lvi. p. 286, 1918.

Grove reports that better specimens prove this variety to be a stage growth of *Ascobolus barbatus*. He refers to note in Trans. B.M.S. iv. p. 367 as "impossible."*

SPHAEROPSIDEAE.

Phyllosticta Camelliae Westend. ex Kickx, Fl. Crypt. Fland. i. p. 416, 1867; *Phoma camelliaecola* Brun., in Act. Soc. Linn. Bord. xliv. p. 243, 1890.

On living leaves of *Camellia japonica*, Ward End Hall, near Birmingham, Dec. 1885: Grove in Journ. Bot. lvi. p. 287, 1918. Brunaud gives the habitat as dead branches.

* Not so impossible as the error in identifying an Ascobolus as a Lachnea! C.R.

Ph. Coryli Westend., in Bull. Acad. Belg. xix. 3, p. 121, 1852.

On living leaves of *Corylus Avellana*, West Kilbride, Ayrshire, D. A. Boyd: Grove (l.c.) considers this to be an early stage of *Labrella Coryli* Sacc.

Ph. Ericae Allesch. ex Sydow in Hedw. xxxvi. Beibl. p. 158, 1897; Grove, loc. cit. p. 288.

On dead leaves of *Erica tetralix*, West Kilbride, Ayrshire: D. A. Boyd, Jan. 1918.

Phyllosticta Hydrocotyles n. sp.

Maculis amphigenis, irregularibus, amplis; pycnidiis hypophyllis, sparsis, immersis, flavo-brunneis, ca. 250μ lat., poro rotundo, 50μ lat., praeditis; sporis hyalinis, oblongis, utrinque guttulatis, 5μ × 2μ.

In foliis *Hydrocotyles vulgaris*. West Kilbride, Ayrshire: D. A. Boyd, Aug. 1915.

Phomopsis Sacc. in Ann. Mycol. iii. p. 166, 1905. *Phoma* subgen. *Phomopsis* Sacc. Syll. iii. p. 66, 1884.

A full account of the British species of this genus has been published by W. B. Grove in the Kew Bulletin, 1917, no. 2, pp. 49–73 (2 pls.). He lists 76 British species with descriptions. As a volume on Sphaeropsideae is promised for an early date it is unnecessary to deal with the species here. The following however are recent discoveries:

Phomopsis alnea Died. Krypt. Fl. Mark Brand. ix. p. 244, 1912.

On twigs of *Alnus glutinosa*, Cheshire; Chatsworth (Ellis), May, June: Grove in Journ. Bot. lvi. p. 290, 1918.

Phomopsis pustulata (Sacc.) Grove in tom. cit. p. 291.

On dead branchlets of *Acer Pseudoplatanus*. Stewarton, Ayrshire (D. A. Boyd), Dec.

Phomopsis subordinaria (Desm.) Trav.

Parasitic on *Plantago lanceolata* at Earlswood Lakes station; Grove in tom. cit. p. 292.

Phomopsis vepris (Sacc.) v. Höhn. in S. B. K. Acad. Wiss. Wien, 1906, p. 681; Grove, tom. cit.

On dead stems of *Rubus*, Eastham Lake, Cheshire (Ellis); Grove, loc. cit.

Phomopsis corticis (Fuck.) Grove in tom. cit. p. 291.

On dead stems of *Rubus*, Meols, Cheshire (Ellis).

Phomopsis Eres (Sacc.) Grove, tom. cit.

On dead twigs of elm, West Kilbride, Ayrshire (D. A. Boyd). Grove states that "Cooke's specimens under this head are incorrectly named."

Phoma anceps Sacc. in Mich. ii. p. 273, 1880. Var. *Polygoni* Grove, in Journ. Bot. lvi. p. 289, 1918.

On stems of *Polygonum cuspidatum* in the Botanical Garden, Birmingham.

Phoma santonensis Sacc. et Syd., Syll. Fung. xiv. p. 868, 1890.

On dead twigs of *Ilex Aquifolium*. Quinton, Worcestershire, March; Grove, tom. cit. p. 290.

Ph. lychnidina Grove tom. cit.

On living leaves of *Lychnis dioica*. West Kilbride, Ayrshire (D. A. Boyd), July 1918.

Ph. Platanoidis Sacc. in Mich. i. p. 360, 1878.

On fading leaves of *Acer Pseudoplatanus*. West Kilbride, Ayrshire (D. A. Boyd), July 1918. Grove (loc. cit.) records the identity of this fungus with *Leptothyrium Platanoidis* Pass. collected in Staffordshire. The latter represents a less developed stage. In both cases *Phleospora Aceris* was present often on the same spot and may be genetically connected.

Phyllosticta punctiformis (Desm.) Allesch. Rabenh. Krypt. Fl. i. 6, p. 129, 1898; Grove, tom. cit. p. 289.

On fading leaves of *Lychnis dioica*. Largs, Ayrshire (D. A. Boyd), Sept.

Sclerophoma von Hoehn., in S. B. K. Akad. Wiss. Wien, Math.-Nat. Kl. cxviii. Abt. 1, p. 1232, 1909; Diedecke in Krypt. Fl. Mark Brandenb. ix. p. 277, 1912; Grove in Journ. Bot. lvi. p. 292, 1918.

A genus resembling *Phoma* but without an ostiole and the lower part of the pycnidium filled with a well-developed stroma, etc. Students are referred again to the forthcoming volume on Sphaeropsideae.

Scl. pithya Died., tom. cit. p. 280; Grove in tom. cit. p. 293.

On small dead branches of *Pinus sylvestris*, King's Lynn (Plowright); Cheshire (Ellis).

Edgbaston Bot. Gard., Birmingham, Mar., Apr.

Dothiorella Fraxinea Sacc. & Roum. Syll. iii. p. 236, 1884; Grove, tom. cit. p. 294.

On bark of ash, Lichfield, Feb. 1887.

Cytospora Myrtilli Grove in tom. cit. p. 294, 1918.

On dead branches of *Vaccinium Myrtillus*, West Kilbride, Ayrshire (D. A. Boyd), March 1918.

Camarosporium Stephensii B. & Br.

Further specimens of this fungus have been collected by D. A. Boyd at Ardrossan, Ayrshire. The stems of the bracken on which the fungus grows bear a number of elongate swellings splitting above, the interior of which are occupied by a line of pycnidia of somewhat irregular form about $225\mu \times 150\mu$ and with thin brown walls. The large muriform spores are borne on short sporophores as already described in Trans. B. M. S. vi. p. 50, 1918.

NECTRIOIDEAE.

Zythia Mercurialis Kickx Fl. Crypt. Fland. i. p. 449, 1867.

Pycnidia scattered or congregate, dull yellow then rust-coloured at length brownish-black, almost globose, with a pore at the apex; spores elongate or ovate, very small.

On leaves, petioles and stalks of *Mercurialis perennis*, Garforth, Yorkshire. No measurements have been recorded but there is no reason to consider the specimens collected as different from the above; the minute yellow pycnidia measure from 100–125μ, the ostiole 25μ in diam. The spores are mostly small, varying from ovoid to ellipsoid, usually about $5\mu \times 2$–$2{\cdot}5\mu$; mixed with these are a few spores almost double in length, and occasionally constricted and septate, $10\mu \times 3\mu$.

LEPTOSTROMATACEAE.

Leptothyrium Fragariae n. sp.

Maculis testaceo-brunneis, parvis vel latis, non limitatis. Pycnidiis epiphyllis, numerosis, sparsis vel gregariis, punctiformibus, convexo-dimidiatis, atris, nitidis, minutis, ad 120μ latis; contextu fuliginoso radiante; centro irregulariter pertuso; sporis cylindraceis, rectis, continuis, hyalinis, 3–6μ long, 1–1·5μ lat.

In foliis langusecentibus *Fragariae vescae*: D. A. Boyd, Largs, Ayrshire, Feb. 1918. The pycnidia cover large areas of the leaf. *Gnomonia Rosae* was also present along the veins on the under surface.

MELANCONIEAE.

Melanconium zonatum Ellis & Ever. in Peck, 44th Rep. N. York State Mus. p. 136, 1890; W. B. Grove in Kew Bull. 1918, p. 164, fig. 3.

Considered by Grove to be British. It has turned up on birch at Byram Park, Selby; the spores agree in size and form with Grove's measurements and drawing.

Myxosporium Polygoni W. B. Grove in Journ. Bot. lvi. p. 340, 1918.

On stems of *Polygonum cuspidatum* in Botanical Garden, Birmingham, associated with *Phoma anceps* var. *Polygoni*.

Marssonia Omphalodis W. B. Grove, loc. cit. p. 342.

On decaying leaves of *Omphalodes verna*, Saltcoats, Ayrshire (D. A. Boyd), July.

HYPHOMYCETES.

Ovularia Doronici Sacc. in Mich. ii. p. 638, 1882.

Spots hypophyllous, spreading, whitish. Conidiophores in tufts, non-septate, shortly branched above or denticulate, 30–40μ long, 3μ thick, colourless; conidia elongate sometimes subfusiform, occasionally in chains, 12–15μ × 4–5μ, colourless.

On the underside of the leaves of *Doronicum Pardalianches*, Flax Bourton, Somerset. Comm. T. M. Roper, Bristol, Feb. 1919.

COREMIUM SWANTONII n. sp.

Stroma simplex albo-ochraceum usque ad 15 mm. alt., 1 mm. lat. vel tenuis ca. 5 mm. × 0·2 mm. Hyphae fertiles capitula singula, 2–3 mm. diam. vel plura coalescentia, sporis pulvereis obtecta, formantes. Hyphae longae, septatae ca. 2μ lat. irregulariter ramosae; verticilli fertiles sparsi ca. 10μ long, pluribus sterigmatibus praediti; sporae minutae ellipsoideae vel globosae, simplices, catenulatae, 3μ × 2μ vel 2μ diam., hyalinae.

Fig. 2. *Coremium Swantonii* A. L. Sm.
a. Wasp with fungus. Nat. size.
b. Head of Coremium. × 5.

In vespa emortua. Blackdown, Haslemere, Surrey: E. W. Swanton.

The fungus is probably saprophytic on the wasp (*V. sylvestris*) which was lying entangled in moss.

Acrostalagmus albus Preuss.

This species was recorded from Cambridge in Trans. B. M. S. i. p. 71, 1897. It has recently turned up in a chemical solution from Coventry. In the solution there was a dense mass of felted hyphae; a culture on glucose agar grew freely producing dense clusters of yeast spores and a vigorous growth of *Acrostalagmus*.

Ramularia Lysimachiarum Lindroth in Acta Soc. Faun. Fl. Fenn. xxiii. p. 28, 1902.

Leaf-spots brown, then dark-green, at length yellowish, often covering complete portions of the leaf from the margin inwards, without a margin. Tufts on both sides of the leaf (mostly under surface), very small, white; conidiophores, 5 to 15 emerging

from the stomata, unbranched, straight, cylindrical, non-septate, slightly unequal-sided, about 18–22μ × 3–4·5μ; conidia, one or two at the tips of the conidiophores, cylindrical, slightly pointed, 2-celled, colourless, 8–30μ × 2–3μ.

On leaves of *Lysimachia Nummularia*, Lochwinnoch, Renfrewshire; D. A. Boyd, July 1918.

The spores are non-septate for a considerable time.

R. Pastinacae Bubák in Sitzb. böhm. Ges. Wiss. Prag. 1903, Sep. p. 19; Cotton in Kew Bull. 1918, p. 18, fig. 1.

On leaves and petioles of parsnip in Worcs., Glos. and Cambs.

Dactylella ellipsospora Grove in Journ. Bot. xxiv. p. 200 (pl. 266, fig. 9), 1886.

A mould somewhat similar to this species was collected on dead wood during the Selby Foray. The stalks are longer and narrower, 130–230μ × 2–3μ, and the spores are narrower, measuring about 40μ × 10–12μ; but the differences do not seem to be specific and Grove's drawings even more truly represent the Selby fungus than do his measurements.

Torula convoluta Harz, in Bull. Soc. Imp. Nat. Moskow (separate), p. 47 (pl. 1, fig. 6), 1871.

Mycelium creeping, richly branched, septate; conidiophores upright, very short, branched or unbranched, septate, terminating in long chains which roll up at the ends; conidia globose, black, transparent, 2·5–3μ in diam.

On decaying and dry potatoes, also on decaying leaves. Found by F. T. Brooks on potatoes in the Isle of Wight, summer, 1918.

Cercosporella Pastinacae Karst. in Hedwigia, xxiii, p. 63, 1884; Cotton in Kew Bull. 1918, p. 19, fig. 2.

On leaves and petioles of parsnip in Worcs., Glos. and Cambs.

Dendryphium curtum B. & Br. Collected at Parlington Park, Selby, Yorkshire.

The fungus developed on branches kept under observation. It agrees with the above species in every respect except in the spores which in the Selby specimen are catenulate, but this is probably due to the very sheltered laboratory conditions.

Cercospora Myrti Erikss., in Bidr. till Känned. odl. växt sjukdomar, Stockholm, p. 79, 1885.

Leaf spots amphigenous, roundish, red-purple. Tufts mostly hypophyllous, the conidiophores in groups; conidia gradually tapering upwards, bent, 3–6 septate, 60–100μ × 2–4μ, brown.

On the leaves of cultivated myrtle. West Kilbride, Ayrshire, Sept. 1918. Comm. D. A. Boyd.

A FLUORESCENT COLOURING MATTER FROM LEPTONIA INCANA GILL.

By Harold Wager, D.Sc., F.R.S.

During the summer of 1917 I found a number of beautiful specimens of *Leptonia incana* in a limestone pasture at Hawkswick, Skipton-in-Craven, about 800 ft. above sea level. The Fungus commonly occurs amongst short grass in woods and pastures and on lawns and downs. Mr. Carleton Rea informs me that he has met with it most years during the months of August and September, and that it has often been found at the Fungus Forays of the British Mycological Society, and Mr. A. E. Peck informs me that it has been recorded many times in various parts of Yorkshire. The pileus is of a beautiful bronze or olive green tint, yellowish bronze-green at the periphery, darker green to bronze in the middle, and striated from the disc to the periphery with dark yellowish green lines on a light yellow ground. The flesh of the stem, pileus, and trama of the gills is light yellow to yellowish-green in colour; all parts of the flesh turn green when bruised, and, when pressed between sheets of paper, the paper is stained greenish-yellow.

Fresh specimens of the Fungus placed in 95 per cent. alcohol give a green solution which shows a brilliant green or green-blue fluorescence. Fresh specimens in distilled water give an opalescent yellow solution with a slight green fluorescence, the colour of the Fungus becoming pale green-blue. If the water is changed several times until no further colour comes out, and the specimens are then drained and placed in absolute alcohol, a blue-green colouring matter is extracted and the solution shows a brilliant dark green-blue fluorescence. If the Fungus is first dried and then placed in alcohol the colour does not come out, but if soaked for a few seconds in water, and then in alcohol, the colour comes out at once. On adding ether to a watery alcoholic solution of the fresh Fungus a small quantity of a yellow colouring matter comes out into the ether; this shows no fluorescence, but the alcoholic green solution below remains fluorescent.

These experiments indicate that there are in this Fungus at least two fluorescent colouring matters, yellow and blue,

and that the green colour is therefore probably due to a combination of these. The yellow pigment is soluble in water; the blue pigment is soluble in alcohol in the presence of a small quantity of water. The two colours can be separated by capillary analysis on a strip of filter paper, by suspending the strip of paper with one end dipping into the alcoholic solution. As diffusion takes place the paper becomes coloured yellow below, and blue-green above.

The green alcoholic solution if allowed to remain in contact with the Fungus soon becomes yellow, but still retains for some time its green fluorescence. The blue pigment apparently becomes changed, in the presence of the Fungus, to a yellow one. This may be due to the action of an oxidase. A similar change takes place in the air dried Fungus. This retains its green colour for some time, but gradually becomes brown. When the dry, brown Fungus is soaked in water a dark yellow solution with a green fluorescence is obtained. Water extracts nearly all the colour, and if, after standing for some time in water, the solution is poured off, and alcohol added, the alcohol remains colourless.

The green alcoholic solution is much more strongly fluorescent than the yellow watery solution, and if the green alcoholic solution is decanted from the Fungus it retains its green colour and strong fluorescence for a long time. After the lapse of some months the solution becomes yellower, but the strong fluorescence is maintained, and after two years is practically as strong as at the beginning. The addition of a little sodium hydrate, ammonium hydrate or hydrochloric acid to the green solution changes it at once to yellow, but the green fluorescence persists. Hydrogen peroxide brings about a slow change in the colour of the green solution to yellowish green but the fluorescence remains.

On evaporating the green alcoholic solution to dryness a yellow amorphous pigment is left which gives when taken up with water or dilute alcohol a yellow fluorescent solution, but in absolute alcohol or ether gives only a faint yellow non-fluorescent solution.

Fluorescent pigments are widely distributed among the Fungi, and they are also formed in many bacteria. Dr. A. Weiss states that the majority of Fungi give a more or less fluorescent pigment in alcohol*, but I find that in many species no fluorescence is visible, and in many others is only very slight. Thus the coloured species of *Hygrophorus* (yellow, green, red) all give a bright orange coloured solution in alcohol with a very slight green fluorescence. The bright green

* S. B. K. Akad. Wiss. Wien, 1885.

Chlorosplenium aeruginosum gives a light yellow-green solution with a very slight green fluorescence. The pink or red Russulas on the other hand usually give red or yellowish solutions with a brilliant blue fluorescence. The yellow or greenish Russulas give yellow solutions with a green or green-blue fluorescence. Rostrup has described the greenish fluorescence of the yellow alcoholic solutions of *Pleurotus serotinus**. A. Ling has observed a greenish fluorescence in beer due to a *Torula*†. A. Kløcker has found that under certain conditions *Aspergillus glaucus* gives a faint green fluorescing pigment to wort in which it is grown. This is soluble in ether and then gives a blue fluorescence. If the ether is evaporated to dryness a yellow residue remains, easily soluble in water to a slightly fluorescent solution‡.

The green fluorescence due to certain bacteria has long been known. Thus *Bacillus fluorescens liquefaciens*, which is very widely distributed, especially in soil and polluted water, shows in ordinary bouillon culture a beautiful green fluorescence§. Several other green fluorescent bacteria have been described. According to Thumm‖ all fluorescing bacteria, when cultivated in alkaline media, produce first a blue fluorescence which afterwards becomes green.

It is of considerable interest to note that in all bacteria, and in all except very few Fungi, the fluorescence should be in the more refrangible, green or blue, part of the spectrum, whereas in chlorophyll solutions, and in solutions of carotin and xanthophyll, the fluorescence is in the red or less refrangible part of the spectrum. In a few Fungi which I have examined the fluorescence is slightly red, and in *Tubaria inquilina* red violet. This may be due to the presence of a carotinoid colouring matter. The colouring matters of the Fungi usually occur in the cell membrane, and it is to these that the green or blue fluorescence is due, but the yellow and dark orange or red colours of many Fungi, *Pilobolus*, spores of *Chytridineae*, many Pezizas and *Uredineae*, *Sphaerobolus*, *Stereum*, etc., are associated with fatty bodies contained in the cells. They give a blue or green reaction with strong sulphuric acid or iodine, and are probably of the nature of carotin and xanthophyll. The yellow and red colouring matters of *Hygrophorus*, *Clavaria* and *Amanita muscaria* are not of this type. They are contained in the cell membranes, and give a green fluorescence. The spore

* Mykologiske Meddelelser, Bot. Tidskr. 1889.
† Jour. Inst. of Brewing, 1915.
‡ C. R. des travaux du Laboratoire de Carlsberg, 1917.
§ See Ellis, Outlines of Bacteriology, 1909.
‖ See Centrbl. f. Bakt. 2nd Abt. 1895.

coloration of the Fungi is also due in the main to colouring matters in the spore membrane, but these are apparently very slightly soluble in alcohol, and so far as I have been able to observe do not give fluorescent solutions. None of these pigments has any resemblance, except colour, to the well-known anthocyan pigments of flowers. Their behaviour with reagents is totally different, and their physical characteristics are not the same. We have very little knowledge of the chemical nature of these fluorescing pigments, or of the conditions under which they are formed. The yellow fluorescent pigment of *Leptonia incana* resembles in some respects the well-known colouring matter fluorescein; both pigments are soluble in dilute alcohol to a yellowish solution, and both give a brilliant green fluorescence. When heated strongly they both give off fumes of volatile matter and carbon is left; the fumes given off by the Leptonia pigment have much the same odour as those given off by the fluorescein. It is not improbable therefore that the fluorescent pigments of the Fungi may be related to that group of colours to which fluorescein belongs, but further investigation is necessary before any satisfactory conclusion can be reached.

The following is a list of the Fungi I have examined which give fluorescent solutions in alcohol*:

Name of fungus	Colour of alcoholic solution	Fluorescence
Amanita muscaria	Yellow-orange	Green
,, *rubescens*	Light yellow-brown	Very slight green
Amanitopsis vaginata var. *fulva*	Light yellow	Light blue
Russula lilacea	Light yellow	Blue
,, *aurata*	Yellow	Blue or blue-green
,, *ochroleuca*	Yellow	Blue or blue-green
,, *xerampelina*	Yellow-red	Blue
,, *emetica*	Yellow-red	Blue
,, *cyanoxantha*	Yellow	Green
,, *vesca*	Red	Bright green-blue
,, *alutacea*	Yellow-red	Brilliant blue
,, *citrina*	Yellow-red	Bright green-blue
,, *virescens*	Orange-red	Blue-green
Leptonia incana	Green or yellow-green	Brilliant blue-green
,, *lampropus*	Yellow-brown	Blue-green
Hygrophorus (yellow, red or green species)	Orange	Slight green
Lepiota granulosa	Light yellow	Very slight green
Laccaria laccata	Light yellow-brown	Light blue-green
Agaricus campestris	Light yellow	Very slight blue-green
Thelephora laciniata	Light brownish-red	Very slight green
Inocybe Godeyi	Light yellow-brown	Very slight green-blue
Stropharia aeruginosa	Yellow	Light blue or green
Hypholoma fasciculare	Yellow-green	Light green

* Cf. Weiss, loc. cit.

Name of fungus	Colour of alcoholic solution	Fluorescence
Coprinus micaceus	Light yellow	Light reddish
Mycena haematopus	Red	Slight green
Entoloma rhodopolium	Yellow-brown	Light blue
Lactarius quietus	Light yellow-brown	Slight green-blue
Tubaria inquilina	Yellow-red	Red-violet
Naucoria temulenta	Dark brown	Very slight yellow-red
Boletus pruinatus	Light yellow	Very slight yellow-green
,, *elegans*	Yellow	Green
,, *chrysenteron*	Yellow	Very slight red
,, *badius*	Dark yellow	Very slight green
Polyporus nidulans	Yellow (in dilute solution)	Very slight blue-green
Tremella mesenterica	Yellow	Light blue
Nectria cinnabarina	Yellow-red	Very slight green
Cordyceps militaris	Yellow	Slight green
Chlorosplenium aeruginosum	Light yellow-green	Very slight green
Clavaria inaequalis	Orange-yellow	Very slight green

The colouring matters vary much in solubility, and it is necessary, when they are easily soluble and give a dark coloured solution, to dilute the solution considerably before the fluorescence becomes clearly visible. The colours of the alcoholic solutions given in the above table are those of solutions diluted sufficiently to show the fluorescence most clearly. I have not attempted to give the results obtained with other solvents than alcohol, for although better solutions were sometimes obtainable with alcohol and hydrochloric acid, or dilute ammonia, the fluorescence remained much the same. Thus *Leptonia lampropus* gave in methylated spirit a light grey-blue solution with a light blue fluorescence, in water a yellowish solution with slight blue fluorescence, in 70 per cent. alcohol a yellow-brown solution with blue-green fluorescence, and in dilute ammonia a reddish violet solution with a green or green-blue fluorescence.

Not all the colouring matters found in any given species of Fungus are fluorescent. Much of the colouring matter which may be extracted in water or alcohol, especially on heating, shows no fluorescence. But with the exception of the carotinoid colouring matters they all occur, along with the fluorescent pigments, in the cell membrane or in the gelatinous or mucilaginous layers of the cell membranes. In many Fungi the characteristic colouring, as in *Amanita muscaria*, appears to be due to pigments contained in the mucilaginous layers, although, as de Bary points out, it is not easy to determine with certainty how the colour is distributed. We have very little knowledge of the functional significance of the colouring matters of the Fungi. From the fact that they are found mainly in the cell membranes and not in the cell contents, and that they

absorb the more refrangible, blue and violet, rays of the spectrum, which have a deleterious action upon protoplasm, they may exercise a protective function against a too intense light*.

The light energy absorbed by the pigments may also be of use in maintaining the tissues at a suitable temperature in order that the metabolic activities of the Fungus may be carried on satisfactorily.

One of the important functions of the Fungus pigments appears to be to render the tissues more resistant. The coloration of the non-gelatinous cell membranes is accompanied with increased firmness, and in most cases with exceptional power of resisting the action of concentrated sulphuric acid, phenomena which recall the similar behaviour of the sclerosed, lignified and suberised membranes of the higher plants†. This is well seen in coloured spores the membranes of which, as compared with those of colourless spores, are very resistant to the action of concentrated sulphuric acid.

No physiological or biological explanation of the fluorescent pigments can be given. Nor can any explanation be given of phosphorescence which also occurs in some Fungi. Both phosphorescence and fluorescence are now classed together as photo-luminescence, and both are due to the stimulus of the light absorbed. Phosphorescent substances are those which continue to emit light for some time after the stimulus is withdrawn; fluorescent substances only emit light during the time the stimulus is acting.

A light yellow alcoholic solution of the pigment of *Leptonia incana* shows a beautiful green colour when a beam of sunlight is passed through it. If, instead of white light, a beam of violet or blue light is allowed to pass through, the same green colour is observed, and the invisible ultra-violet rays are also able to produce the same effect. The blue, violet or ultra-violet rays on being absorbed by the solution at once set up disturbances in the colouring matter by which light of a different wave-length is emitted. Stokes stated that the wave-length of the fluorescent radiation is always longer than that of the radiation which excites fluorescence. Recent investigations have however shown that this is not always the case, and according to Nichols the absorption band, to which fluorescence is due, and the fluorescent spectrum overlap, and all the waves included in the absorption band can produce the excitation. The yellow fluorescent solution of *Leptonia incana* shows a strong absorption at the more refrangible end of the spectrum extending from the extreme violet to about the line *E* and

* Cf. Buller, Researches on Fungi.

† De Bary, Comparative Morphology and Biology, etc., of the Fungi.

including the violet, blue and green rays. The exciting rays capable of bringing about fluorescence extend from the ultra-violet to the blue-green part of the spectrum up to about the line *F* and the spectrum of the fluorescent radiation includes the blue-green, green and yellow-green part of the spectrum. There is here therefore some overlapping of the absorption band and the emission spectrum.

According to the views at present held by physicists the light absorbed, both in phosphorescent and in fluorescent substances, brings about a partial or complete separation of electrons from the atoms of the substances acted upon. Both fluorescence and phosphorescence are therefore to be regarded as photo-electric phenomena*.

In the Fungi phosphorescence appears to be due to the activities of living cells, but fluorescence is only visible in solutions of the colouring matter extracted from the plant by solvents.

A REVISION OF THE BRITISH CLAVARIAE.

By A. D. Cotton, F.L.S., and E. M. Wakefield, F.L.S.

INTRODUCTION.

The work on which the present revision is based was begun in 1905. It was originally intended to include in the study all the described species of Clavaria, numbering now about 400, and to publish a systematic monograph of the whole genus. As the work progressed however it became apparent that, before any attempt could be made to monograph the genus, it was essential to clear up the confusion which existed with regard to the old European species.

Microscopic structure had shown new ways of distinguishing species and also that several undescribed species occurred even in Britain. It was obvious, therefore, that it was only by prolonged and careful field work, coupled with an investigation of the micro-characters, that a true understanding of the genus could be obtained and the old descriptions and original specimens be correctly interpreted.

As a result of this preliminary work it was decided to limit the revision in the first place to the British species, but to include during the investigation as many continental and extra-European species as came to hand, with a view to publishing

* Allen, Photo-electricity.

a monograph at a later date. The present revision does not profess to furnish a complete list of the British species. Indeed it is clearly preliminary, since many specimens had to be left unidentified, and species apparently new continue to appear every season. We feel confident however that the interpretation here given of the old and doubtful species is in the main correct and that, though new species may be added, little fundamental alteration will be necessary. As it has not been possible to pay detailed attention to the subject since 1914, and as there is no prospect of doing so in the immediate future, it seems advisable to publish without further delay the results so far obtained.

With regard to the diagnostic characters adopted, we have used micro-characters in conjunction with field characters. The form and size of the spore, except in the ochraceous-spored section where they are singularly uniform, proved surprisingly varied and useful. But although so invaluable we have never used micro-characters in separating one species from another unless the plant was also amply distinct in form, colour, or other field character. The spores in some cases afford a more accurate and precise means of expressing the difference between allied species than form or colour. This is well seen in the yellow unbranched section and especially in the case of the two species *C. inaequalis* and *C. persimilis*. To the trained eye these are usually distinguishable in the field, but at times the colour is identical. If examined with the microscope, however, the oblong spore of the latter with its marked lateral apiculus immediately separates it from the globose spinose spore of the former, and if the specimens are sorted out by this method the separation is confirmed by the difference in colour which is assumed on drying.

The variation of the spore both in form and size, and hence the difficulty in gauging its value as a diagnostic character, has been commented on by several writers, both systematists and experimentalists, e.g. Sherbakoff in the case of Fusarium, Brierley in Botrytis, and by Thom to a lesser extent in the case of Penicillium. The present study has not revealed any marked variation in the genus Clavaria, but merely that which any systematist would consider normal for the Hymenomycetes and indeed for the larger fungi generally. The spores of all species of Clavaria vary within certain limits, and those of some species much more so than others; indeed the tendency to great variation may be regarded as characteristic of certain species. In connection with spore-measurements two points must be borne in mind, (1) the necessity of dealing with mature spores and (2) the possibility of the existence of strains or races which

may differ in several respects from the typical species. With regard to the former, for ordinary systematic purposes the use of the usual spore-cast provides a sufficiently good safeguard, although the possibility of obtaining exceptional spores is not excluded by this method (see, for instance, these Trans. vol. iv. pp. 298–300). With reference to strains, the existence of these in many parasitic species has been definitely proved, and though perhaps less general it occurs also amongst the Hymenomycetes, as has been shown with respect to the formation of fruit-bodies in *Schizophyllum commune* and *Stereum purpureum* (Naturwiss. Zeitschr., 1909, p. 521). It will be noted that the fungi alluded to above (Fusarium, etc.) are Hyphomycetes and it would appear that, owing perhaps to the great diversity of substrata on which they exist, they are more liable to vary than the Hymenomycetes.

The list as given in the present revision consists of 37 species. Two of these, *C. Broomei* and *C. Invalii*, we have been compelled to describe as new, and four other novelties were described during the progress of the work, viz., *C. gigaspora*, *C. Crosslandii*, *C. straminea* and *C. persimilis*. In two cases only has it been necessary by following the International Rules of Nomenclature to change a name. *C. muscoides* Linn. becomes *C. corniculata* Fr., and *C. conchyliata* Allen becomes *C. Bizzozeriana* Sacc. One plant usually listed in British works as a species, *C. fastigiata*, is reduced to the rank of a variety (*C. corniculata* var. *pratensis*) and 22 names have been excluded from the British list as synonyms or indeterminable.

With regard to the citation of synonyms and illustrations the list, though fairly full, does not profess to be completely exhaustive. Well-known names have in all cases been cited, but doubtful names have been omitted. Of illustrations, those occurring in British works have been quoted, and a selection has been made from other works, choosing those which are well known and best represent the species in question.

Before closing this introduction we would acknowledge our indebtedness to all who have helped the work by forwarding specimens. Many of the species are so rare in this country that but for their aid there would have been little chance of examining fresh material. As practically every working member of the British Mycological Society has helped in this way, it is impossible to mention each one individually. The late Mr. G. Massee suggested the work and liberally handed over a number of notes and drawings. Mr. Carleton Rea's help was invaluable, and we are indebted to Mrs. Rea for the loan of her matchless collection of paintings together with notes. Amongst other members of the Society who have

whole-heartedly helped mention may be made of Mr. C. Crossland, the Rev. W. L. W. Eyre, Miss A. Fry, Mr. C. H. Spencer Perceval, and Mr. E. W. Swanton. We have also received specimens from American, French, Swiss and German botanists, whilst the Abbé G. Bresadola was always ready to supply specimens and notes from the Austrian Tyrol. For a collection of specimens from the classical ground near Upsala we are indebted to Mr. C. G. Lloyd. To these mycologists and to all others not mentioned by name we record our sincere thanks.

In the case of certain rare species we have indicated the localities. These are limited to Britain and include only those from which material has been received during the preparation of this revision. No attempt has been made to investigate the specimens contained in the public and private herbaria of this country.

KEY TO THE BRITISH SPECIES OF CLAVARIA.

A. Plants branched.

1. Plants when mature more or less yellowish, spores ochraceous.

(*a*) Plants large, up to 10 or 15 cm. high; spores 9–20μ long.

Plant fragile, pale when dry; spores pale ochraceous, minutely granular, 11–14 × 4–5μ ... ... 1. *C. flava*

Plant somewhat fragile, dark when dry; spores deep ochraceous, echinulate, 15–16 × 6–7μ ... ... 2. *C. Broomei*

Plant white to ochraceous, tips of branches rosy; spores striate or reticulate ... ... 3. *C. botrytis*

Plant buff-pink, tips of branches yellow; spores minutely granular ... 4. *C. formosa*

(*b*) Plants medium-sized, up to 5 cm. high; spores 6–10μ long.

Growing on wood, vinous to brownish yellow ... ... 5. *C. stricta*

Growing on the ground in coniferous woods

Plant turning green when bruised 6. *C. abietina*

Plant not turning green when bruised

Plant slender, flaccid; spores 6–7 × 3μ ... ... 7. *C. flaccida*

Plant stout, rigid; spores 7–9× 4μ 8. *C. Invalii*

2. Plants variously coloured, spores hyaline.

(*a*) Plants white.

Branches cristate; spores large, subglobose, 9–12 × 6–8μ ... ... 9. *C. cristata*

Branches not cristate; spores small, globose, 3–5μ ... ... 10. *C. Kunzei*

(*b*) Plants greyish.

Spores subglobose, 7–10 × 6–8μ ... 11. *C. cinerea*

Spores very large, pip-shaped, 12–16 × 7·5–8μ ... ... 12. *C. gigaspora*

(*c*) Plants violet.
Plant medium sized, fleshy; spores subglobose, 5–7μ ... ... 13. *C. amethystina*
Plant very small, slender; spores globose, 2·5–3·5μ ... ... 14. *C. Bizzozeriana*
(*d*) Plants clear yellow; spores subglobose, 6–7μ ... ... 15. *C. corniculata*
(*e*) Plants pale umber, spores pip-shaped, 5–6 × 3–4μ ... ... 16. *C. umbrinella*

B. Plants simple (occasionally branched in 21).

1. Plants tufted.
Plant white; spores subglobose, 3–5 × 3–4μ 17. *C. vermicularis*
Plant grey; spores elliptical or pip-shaped, 6–8 × 3–4μ ... ... 18. *C. fumosa*
Plant yellow; spores globose, 5–7μ ... ... 19. *C. fusiformis*

2. Plants solitary or in small groups.
(*a*) Plants white.
Plant very slender, smooth; spores subglobose, 8–9 × 7–8μ ... ... 20. *C. acuta*
Plant stout, rugose, sometimes branched; spores subglobose, 9–11 × 8–9μ ... ... 21. *C. rugosa*
Plant small, slender; spores aculeate, globose, 7–8μ (without spines) ... 22. *C. asterospora*
(*b*) Plants drab or greyish.
Plant with a distinct stalk, thickened above; spores ovoid, 8 × 4μ ... 23. *C. tenuipes*
Plant slender, brittle, without a distinct stalk; spores small, pip-shaped, 4–5 × 2–3μ ... ... 24. *C. Crosslandii*
(*c*) Plants reddish or purple.
Plant bright rose-pink ... ... 25. *C. rosea*
Plant purplish-brown ... ... 26. *C. purpurea*
Plant dingy flesh-colour or pale chocolate ... ... 27. *C. incarnata*
(*d*) Plants yellow.
Spores aculeate ... ... 28. *C. inaequalis*
Spores smooth.
Plant straw-coloured, becoming brownish when bruised, apex usually acute; spores globose, 5–7μ 29. *C. straminea*
Plant greenish-yellow, not becoming brownish when bruised, apex usually blunt; spores 10–11 × 5–6μ ... ... 30. *C. argillacea*
Plant apricot-yellow, pale buff when dry; spores ovoid, 6–7 × 3μ 31. *C. luteo-alba*
Plant orange-yellow, darker when dry; spores subglobose to oblong, 5–6 × 4μ ... ... 32. *C. persimilis*
(*e*) Plants ochraceous to brownish.
Plant very large and stout, clavate, dingy yellow to brown ... ... 33. *C. pistillaris*
Plant medium sized, up to 1·25 cm. thick, ochraceous ... ... 34. *C. ligula*
Plant very long, subulate, pale yellow to rusty, growing on branches; spores 10–17 × 7–9μ ... ... 35. *C. fistulosa*
Plant short, contorted, erumpent, on branches of Alder; spores 17–23 × 8–10μ ... ... 36. *C. contorta*
Plant filiform, rusty to brownish; spores 8–11 × 4–5μ ... ... 37. *C. juncea*

A. Plants Branched.

1. *Plants when mature more or less yellowish, spores ochraceous.*

(*a*) Plants large, up to 10 or 15 cm. high; spores 9–20 μ long.

1. Clavaria flava *Fr.*, Syst. Myc. i. p. 467; Maire in Bull. Soc. Myc. Fr. xxvii. 1911, p. 450.

C. flava Pers., Comment. p. 43; *Ramaria coralloides flava* seu *lutea* Holmsk., Beata ruris, 1790, p. 117; *C. sanguinea* Pers., Obs. Myc. ii. 1799, p. 61, tab. 3, fig. 3; *C. lutea* Venturi, Mic. Bresc. tab. 41, fig. 4.

Illustrations: Holmsk., Fung. Dan. i. tab. 31; Pers., Obs. Myc. ii. tab. 3, fig. 3; Schaeff., Icon. Fung. tab. 175; Barla, Champ. Nice, tab. 40, fig. 5; Bres., Fung. Mang. tab. 100; Fries, Sver. Atl. Svamp. tab. 26; Schaeff., Icon. Fung. tab. 175; Vittadini, Fung. Mang. tab. 29, figs. 2, 3; Venturi, loc. cit.

Plants large, branched, 8–13 cm. high, fleshy, fragile, ochraceous, becoming paler on drying and reddish when bruised; smell pleasant, taste mild. *Stem* thick, white or tinged reddish. *Branching* irregular or irregularly dichotomous, repeated, axils acute, not flattened; branches slender, cylindrical, erect, solid, smooth or slightly wrinkled, apices blunt or pointed. *Flesh* white, soft. *Internal structure* of slightly interwoven hyphae, 8–12 μ in diameter, sub-parenchymatous in transverse section. *Basidia* 45 × 10 μ, finely granular; sterigmata 4, erect. *Spores* pale ochraceous in the mass, almost hyaline by transmitted light, narrowly elliptical, incurved at the base, walls slightly granular, 11–14 (–15) × 4–5 μ.

Habitat. On the ground, in both coniferous and frondose woods.

Rare. Specimens from Morpeth (C. H. Spencer Perceval, 1906, 1909); Bodmin (A. D. C., 1906); Tobermoray, Isle of Mull (A. D. C., 1910); New Forest (G. Massee, 1903, and [Lyndhurst] A. D. C., 1916).

Of the three large species of Clavaria found in Britain this is the least rare. It appears to be not infrequent also on the Continent, at all events in France and Switzerland. It is found in both coniferous and frondose woods (especially beech), where it occurs either isolated or in groups as a pale fragile plant, with a marked tendency to become reddish at the base or when bruised. The colour is pale ochraceous, paler and yellower than in *C. formosa*, which has a tendency to become dull pink.

The correct identity of the three species, *C. flava* Pers., *C. formosa* Pers., and *C. aurea* Fr. is a very perplexing problem,

and one which owing to the scarcity of authentic material and meagreness of the original descriptions it is perhaps impossible to solve. There can be little doubt that the plant here referred to as *C. flava* is the same as that described by Persoon under the same name, and in this view we have the support of Maire (loc. cit.). In this country it has been usually referred to as *C. aurea*, an error which arose largely as the result of Fries' statement that *C. aurea* differed from *C. flava* in its ochraceous spores. This was incorrect, as in all the species of this section the spores are coloured, though in some species more so than in others.

With regard to *C. aurea* it is difficult to dogmatise as to its identity. The English specimens so named consist as stated above for the most part of *C. flava*, but a few which as far as can be seen from herbarium material only differ in possessing shorter spores may be distinct also in other characters, and these may possibly represent the *C. aurea* of Fries. Until the Swedish species of Clavaria have been critically worked out it is advisable not to attempt to describe the plant or list the species for Britain.

2. C. Broomei *Cotton et Wakefield*, sp. nov.

Sporophorum ramosum, circa 5–8 cm. altum, 2–4 cm. diametro, haud fragile, ochraceo-aurantiacum, apicibus aurantiacis, tactu brunnescens, basi albidum. *Stipes* brevis, albidus, tactu rubescens, vix radicans. *Ramuli* subdichotomi, cylindrici vel compressi, breves, solidi, erecti, laeves vel rugulosi, apicibus compressis. *Caro* solida, alba, demum vinosa. *Hyphae* 3–6μ diametro, dense aggregatae. *Basidia* 40–50 × 8–9μ, granulosa, 2-sterigmatica. *Sporae* copiosae, fulvo-ochraceae, oblique fusiformes, aculeatae, 14–20 × 6–8μ.

Habitat. Ad terram in silvis. Warleigh Common, near Bath, C. E. Broome, 1866; Batheaston, C. E. Broome; Meathop Fell, near Grange, Westmorland, chiefly under Holly, collected by J. Wilfrid Jackson, and forwarded by Harold Murray, 1909 and 1911.

Plants somewhat branched, medium to large, 5–8 cm. high, 2–4 cm. across, rather tough, ochraceous orange, tips darker orange, turning brown easily on bruising, base white or pinkish; smell slight, not pleasant, taste bitter. *Stem* short, not swollen, white, becoming pinkish on bruising; rooting base small. *Branching* irregular or somewhat dichotomous, slight below, more frequent above, axils not rounded; branches cylindrical or flattened, short, solid, fairly erect, smooth, or the larger branches much wrinkled, tips flattened. *Flesh* solid, white, becoming vinous later, especially below. *Internal structure*

composed of fine filaments, densely packed, slightly interwoven, 3–6μ in diameter, with vesicular ends 10–12μ in diameter, not pseudoparenchymatous in transverse section; large crystals present in abundance in the tissue. *Basidia* not conspicuous, 40–50 × 8–9μ, contents granular; sterigmata 2. *Spores* deep ochraceous or even orange in the mass, copious, obliquely fusiform or pip-shaped, markedly aculeate, 14–20 × 6–8μ (average 15–16 × 6–7μ).

This species is clearly allied to *C. formosa*, but it is distinguished from it and still more from *C. flava* by its darker hue, and by the deeply coloured and distinctly aculeate spores. On drying it becomes nearly black in colour, whereas *C. formosa* and *C. flava* remain pale, and are somewhat more brittle. It is not possible to identify this species with Fries' *C. aurea*, the spores being quite different from those of an authentic specimen of *C. aurea* in the Kew Herbarium: moreover among all the specimens so named from the Continent not one has been found agreeing with *C. Broomei*.

There can be no question that the specimens forwarded by Mr. Harold Murray agree with those collected by Broome in 1866. These latter were named *C. formosa* by Berkeley, and were distributed under this name by M. C. Cooke in Fungi Britannici Exsiccati (No. 230 and Ed. 2, No. 411). The first record of *C. formosa* as British was made by Berkeley and Broome in 1865 (Ann. and Mag. of Nat. Hist. ser. iii. 15, 1865, p. 321, No. 1031). It was based on specimens collected by Broome at Bathford Down, but although these specimens have not been found, from the description of the spores as "buff, broadly fusiform, granulated," there is little doubt that the species in question was *C. Broomei* and not *C. formosa*.

C. Bataillei Maire (Ann. Myc. xi. 1913, p. 351) has also verrucose spores, but they are smaller and paler than those of the present species, and the plant differs in the violet colour of the branches. *C. testaceo-flava* Bres. is distinguished by the smaller basidia and spores, and by the fact that the spores are minutely granular, not distinctly aculeate.

3. C. BOTRYTIS *Fr.*, Syst. Myc. i. p. 466; Bourdot & Galzin in Bull. Soc. Myc. Fr. xxvi. 1910, p. 213; Maire in Bull. Soc. Myc. Fr. xxvii. 1911, p. 449.

C. botrytis Pers., Comment. p. 42; *C. plebeja* Wulf., in Jacq. Misc. Aust. 2, p. 101, tab. 13; *Ramaria coralloides apicibus purpureis* Holmsk., Beata ruris, 1790, p. 117; *C. acroporphyria* Schaeff., Icon. Fung. tab. 176; *C. rufescens* Schaeff., ibid. tab. 288; *C. purpurascens* Paulet, Traité des champ. tab. 194, fig. 6.

Illustrations: Pers., loc. cit. tab. 3, fig. 3; Atkinson,

Mushrooms, p. 201, fig. 202; Badham, Esc. Fung. tab. 16, fig. 2 (*C. coralloides*); Barla, Champ. Nice, tab. 40, figs. 1–3; Bres., Fung. Mang. tab. 101; Fries, Sverig. Atl. Svamp. tab. 35; Gillet, Champ. Fr. tab. 507; Holmsk., Fung. Dan. i. 1799, tab. 32, fig. *b*; Krombh., Abbild. u. Beschreib. tab. 53, figs. 1–3; Paulet, loc. cit.; Schaeff., loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24D, figs. 2, 3 (but spores not correct); Vittadini, Fung. Mang. tab. 29, fig. 1; Weberbauer, Pilze, tab. 10, fig. 1.

Plants large, 10–12 cm. across and 7–12 cm. high, forming fleshy rounded masses, with a short stout base, densely branched above, white to buff, the tips of the branches reddish; smell slight, pleasant, taste pleasant. *Stem* short, stout, white tapering below. *Branching* irregular, primary branches few and stout (2–3 cm.), ultimate branches slender (2–3 mm.), more or less dichotomous; branches cylindrical, somewhat erect, smooth, pruinose, apices pointed or toothed. *Flesh* solid, white. *Internal structure* of parallel septate hyphae, cells 100–150 × 10μ in the centre, smaller towards the margin, scarcely parenchymatous in transverse section. *Basidia* long, conspicuous, 60–70 × 8–10μ, contents very granular; sterigmata 2–4. *Spores* dull ochraceous in the mass, copious, obliquely elliptical, apiculate, smooth, but with fine longitudinal or oblique striations often anastomosing to form a network, 12–16 × 4–5μ.

Habitat. On the ground amongst leaves in woods. Very rare. Specimens from Haslemere (E. W. Swanton, 1905, 1906, 1913); Byfleet (Lady Davy, 1912); Effingham, under beech and holly (A. D. C., 1913); Lyndhurst (A. D. C., 1916).

As remarked by Persoon, the habit of this species is very variable. The typical form is white or pale, and has short, densely crowded, rose-tipped branches, forming a compact rounded mass. With age it becomes more yellowish in colour, and under certain conditions the branches may become much elongated, as figured by Barla, tab. cit. fig. 3, and Vittadini. It would seem that such elongated specimens have been sometimes referred to *C. formosa*, whence has arisen the idea amongst some recent writers that *C. formosa* has red-tipped branches.

Even when old, however, *C. botrytis* may always be recognised by its characteristic, striate spores, as was noted by us and pointed out by Maire (loc. cit.). Maire suggests that *C. Rielii* Boud. (Bull. Soc. Myc. Fr. xiii. 1897, p. 14) and *C. sculpta* Beck (Verh. k. zool.-bot. Ges. Wien, 39, 1889, p. 603) may have been old specimens of *C. botrytis* from which the branches had been for the most part broken off. The fact that the striations of the spore wall are not mentioned by these authors may merely

be due to the fact that they did not examine the spores with a sufficiently high magnification.

4. C. FORMOSA *Fr.*, Syst. Myc. i. p. 466.

C. formosa Pers., Comm. p. 41; ? *C. fastigiata* Batsch, Elench. tab. 11, fig. 48; *C. coralloides purpurea* Holmsk., Fung. Dan. i. 1799, p. 116, tab. 30, p.p.; *Clavariella formosa* Karst., Hattsv. ii. 1882, p. 185.

Illustrations: Pers., Ic. et Descr. i. tab. 3, fig. 6; Gillet, Champ. Fr. Hymen. tab. 511; Holmsk., Fung. Dan. i. 1799, tab. 30 (*b* and *c*); Krombh., Abb. u. Beschreib. tab. 54, figs. 21–22; Rolland in Bull. Soc. Myc. Fr. ix. 1893, tab. 4, fig. 8; Weberbauer, Pilze, tab. 10, fig. 2.

Plants large, about 15 cm. in diameter, gregarious, much branched, very fragile, colour pinkish buff, pale at first but deeper later, the tips of the branches yellowish or very slightly tinged with pink, every part turning violet and finally black when bruised; taste slight, smell none. *Stem* white at first, then deep pinkish buff, rooting base absent. *Branching* irregular or irregularly dichotomous, axils slightly flattened; branches erect, cylindrical or flattened, elongated, distinctly grooved, 1 cm. thick below, 2 mm. above, apices blunt. *Flesh* white, solid. *Internal structure* of frequently septate irregular hyphae, loosely interwoven in the centre, 6–8 (–10)μ wide, occasionally swollen up to 14μ at the septa, more slender and more closely interwoven towards the margin, somewhat parenchymatous in transverse section. A few latex hyphae present. *Basidia* not conspicuous, 30–40 × 6–8μ; sterigmata 4, erect. *Spores* pale-coloured, ochraceous in the mass, elliptical, apiculate, minutely granular, almost smooth, 9–11 × 5μ.

Habitat. On the ground under trees (beech). Lyndhurst, Sept. 1916, growing in a large semicircle.

Very rare in Britain. The above description is drawn up from the Lyndhurst specimens, which on the whole appear to agree better with the older descriptions of *C. formosa* than some of the British plants which have been so referred.

As here understood, *C. formosa* is a large, very fragile plant, differing from *C. botrytis* in the fact that the apices of the branches are yellowish, or at most slightly tinged pinkish, and in the granular, not striate spores. It is distinguished from *C. flava* and *C. aurea* by the pinkish buff colour, which is somewhat like that of *C. stricta*. The original record of *C. formosa* in Britain, by Berkeley and Broome (Ann. Nat. Hist. ser. 3, vol. xv. 1865, p. 321), appears to have been based on a plant which was distinct from any of these species, and which is here described as a new species (*C. Broomei*), while some of the later

records, such as the Haslemere specimens, have been old specimens of *C. botrytis*, as is pointed out in the notes on that species.

(*b*) Plants medium-sized, up to 5 cm. high; spores 6–10μ long.

5. C. STRICTA *Fr.*, Syst. Myc. i. p. 468.

C. stricta Pers., in Ust. Annal. xv. 1795, p. 33; Comment. p. 45; *Clavariella stricta* Karst., Hattsv. ii. 1882, p. 188; *Clavaria Kewensis* Mass., in Journ. Bot. 34, 1896, p. 470.

Illustrations: Pers., Comment. tab. 4, fig. 1; Berk., Outl. tab. 18, fig. 5; Bull., tab. 358, figs. A, B (*C. crispula* Fr.); Weberbauer, Pilze, tab. 10, fig. 3; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 23, fig. 2.

Plants branched, 3–5 cm. high, gregarious, tough, ochraceous, tinged with vinous (or pale pinky buff), apices pale yellow; smell strong, spicy, taste bitter. *Stem* distinct, thick, short, tough, with root-like strands of white mycelium at base. *Branching* irregularly dichotomous, axils acute; branches slender, cylindrical or sometimes compressed, erect, attenuated, apices somewhat pointed, slightly incurved, solid. *Flesh* concolorous. *Internal structure* of interwoven hyphae, 4–10μ in diameter, not parenchymatous in transverse section; central hyphae often rather thick-walled. *Basidia* distinct, 30–40 $\times$ 7–9μ, contents granular; sterigmata 4, erect. *Spores* ochraceous in the mass, almost hyaline by transmitted light, pip-shaped, almost smooth, 7–10 $\times$ 3–5μ (average 8–9 $\times$ 4μ), guttulate or granular.

Habitat. On rotten wood, stumps, etc., or on the ground in the vicinity of logs. Rather common.

Distinguished by its lignicolous habitat, the white cord-like mycelium, and the bitter taste. The branches are unusually parallel to each other and form a compact fascicle.

C. STRICTA var. ALBA, var. nov.

Apparently an albino form which resembles the type form in all respects, except that the colour is entirely creamy-white.

Habitat. On the ground amongst fallen leaves, twigs, etc. Drumnadrochit, N.B. (Angus Grant, 1908, 1912).

6. C. ABIETINA *Fr.*, Syst. Myc. i. p. 469.

C. abietina Pers., Comm. p. 46; *Clavariella abietina* Karst., Hattsv. ii. 1882, p. 185.

Illustrations: Cooke, Handb. p. 330, fig. 88; Flor. Dan. tab. 2030, fig. 2; Greville, Scott. Crypt. Flor. tab. 117; Massee, Brit. Fung. Flor. i. p. 74, figs. 2–3; Pat., Tab. Anal. fig. 566.

Plants much branched, forming spherical tufts, 3–5 cm. high, tough, deep dull ochraceous in colour, becoming greenish when bruised; smell strong, taste bitter. *Stem* short, thick, whitish, downy, with a slightly rooting base, becoming greenish. *Branches* slender, 1–2 mm. thick, erect, repeatedly forked, cylindrical or compressed, longitudinally wrinkled when dry, apices pointed or bifid, axils acute. *Flesh* white. *Internal structure* filamentous, hyphae loosely interwoven, 4–10μ (average 5–7μ), slightly septate. *Basidia* small, 35–40 × 7–8μ, contents uniform, finely granular, sterigmata 4, erect. *Spores* deep ochraceous in the mass, copious, finely rough, pip-shaped, 7–10 × 3–5μ (average 7–8 × 3–5μ).

Habitat. On the ground in fir woods. Fairly common.

Easily distinguished from all other British species by becoming green when bruised. It is allied to *C. flaccida* and *C. Invalii*, and occurs in similar localities. The spores are larger than those of *C. flaccida*, and more like those of *C. Invalii*.

7. C. FLACCIDA *Fr.*, Syst. Myc. i. p. 471.

Clavariella flaccida Karst., Hattsv. ii. 1882, p. 186.

Illustrations: Fries, Icon. Hymen. tab. 199, fig. 4; Karsten, Finl. Basidsv. tab. 9, fig. 139; Pat., Tab. Anal. fig. 39.

Plants branched, small, 3–4 cm. high, gregarious, rather tough, but flaccid, bright ochraceous in colour, tips paler, base whitish, does not turn green on bruising; smell and taste slight, pleasant. *Main stem* very short, white, with white, floccose mycelium. *Branches* very crowded, repeatedly forked, erect, upper axils rounded, the pointed terminal branches usually curving inwards towards each other, solid. *Flesh* white. *Internal structure* composed of loosely interwoven, slightly septate filaments, 7–10μ in diameter, not parenchymatous in transverse section and more densely arranged towards the periphery. *Basidia* small, conspicuous, 30 × 7–9μ, contents finely granular; sterigmata 4. *Spores* not copious, ochraceous, very finely punctate, pip-shaped, 6–8 × 3–5μ (av. 6–7 × 3μ), sometimes with a hyaline basal tip.

Habitat. Amongst moss and leaves in coniferous woods. Not common.

Specimens from Alresford, Hants. (C. Rea, 1904, and W. L. W. Eyre, 1911); Midhurst (E. M. W., 1913); Lyndhurst (A. D. C., 1916). Recorded at the Rothiemurchus (1900), Exeter (1901), and Savernake Forest (1903) forays.

Somewhat resembling *C. abietina*, but the whole fungus is more flaccid, and does not turn green when bruised. Stem sometimes up to 1·75 cm. long, at others almost obsolete. Mycelium whitish, creeping over leaves, etc.

8. C. Invalii *Cotton et Wakefield*, sp. nov.

Fungus dense ramosus, 4–5 cm. altus, rigidus, ochraceus. *Stipes* brevis, albido-tomentosus, basi radiculis mycelialibus albis vel flavidis instructus. *Rami* tenues, breves, cylindrici, erecti, laeves, apicibus acutis, intus solidi, albido. *Hyphae* irregulares 5–10μ diametro, laxe intertextae. *Basidia* 30–40 × 7–9μ, intus granulosa; sterigmata 4, erecta. *Sporae* copiosae, ochraceae, obovatae, basi leviter incurvatae, echinulatae, 7–9 × 4μ.

Habitat. On the ground amongst leaves in thick plantations of spruce, larch, etc. Inval, Haslemere, E. W. Swanton, 1905–1908.

Plants solitary or gregarious, branched, forming dense compact, almost spherical tufts, 4–5 cm. high, tough, rather rigid, deep ochre in colour; smell slightly pungent, taste faint, hardly bitter. *Stem* more or less distinct, short, often woolly, with white or yellowish rooting strands. *Branching* irregular, frequent, axils acute; branches slender, short, uneven, cylindrical, erect, smooth, solid, apices attenuated and pointed. *Flesh* white. *Internal structure* of irregular, wavy filamentous hyphae, 5–10μ in diameter, loosely interwoven and running equally in each direction. *Basidia* conspicuous, 30–40 × 7–9μ, contents finely granular; sterigmata 4, erect. *Spores* abundant, yellow, pip-shaped, slightly incurved at the base, echinulate, 7–9 × 4μ (average 8 × 4μ).

This species, which is obviously very rare in Britain, has been sent to us repeatedly from the spruce plantations at Inval, near Haslemere, by Mr. E. W. Swanton. It is perfectly distinct from all other species we have received and being unable to place it with certainty in any Continental species we have been compelled to describe it as new. The plant is closely allied to *C. abietina* and *C. flaccida*. From the former it differs in not turning green when bruised and retaining its deep bright colour when dried, and from the latter in its stouter form, more rigid habit, and larger and more deeply coloured spores.

2. *Plants variously coloured, spores hyaline.*

(*a*) Plants white.

9. C. cristata *Fr.*, Syst. Myc. i. p. 473.

C. cristata Pers., Syn. p. 591; *Ramaria cristata* Holmsk., Beata ruris, 1790, p. 92; *Ramaria ornithopodioides* Holmsk., ibid. p. 26; *Clavaria fallax* Pers., Comment. p. 48; *C. fallax* var. *cristata* Pers., ibid.; *C. trichopus* Pers., Comment. p. 50; *C. albida* Schaeff., Icon. Fung. tab. 170; *Clavulina cristata* Schroet., Pilz. Schles. i. p. 442.

Illustrations: Pers., Comment. tab. 2, fig. 4, and tab. 4, fig. 3; Berk. in Ann. Nat. Hist. i. 1838, tab. 5, fig. 46 (hymen.); Fries, Sver. Atl. Svamp. tab. 92, figs. 1–5; Greville, Scott. Crypt. Flor. tab. 190; Holmsk., Fung. Dan. i. 1799, tabs. 20, 23; Pat., Tab. Anal. figs. 37, 261; Quélet, loc. cit.; Weberbauer, Pilze, tab. 10, fig. 4.

Plants branched, 3–8 cm. high, gregarious, fragile, pure white, pinkish white, or with a tinge of mouse-grey; smell none, taste distinct. *Stem* short, slender or stout. *Branches* numerous, irregular, flattened upwards, and divided at the tips into sharp-pointed branchlets; axils rounded. *Flesh* white. *Internal structure* composed of loosely interwoven, more or less parallel filaments, fairly regular, frequently septate, segments 35–40 × 5–6μ, in the centre 50–70 × 6–9μ. *Basidia* small, 25 × 6–7μ, contents densely granular; sterigmata 2. *Spores* smooth, hyaline, subglobose, apiculate, 9–12 × 6–8μ (av. 9 × 7μ or 7–8μ diam.), with a large conspicuous oil-globule.

Habitat. On the ground in woods, etc. Very common.

We have retained this species in the sense in which it is usually understood, but not without some misgivings. It is obviously nearly allied to *C. cinerea*, and small crested forms of the latter are difficult to distinguish from certain forms of *C. cristata*. It is noteworthy also that *C. cristata* usually occurs in more shaded spots, and frequently covered with leaves or screened by logs of wood.

The black parasitic mould *Scoletotrichum Clavariarum* occurs perhaps more frequently on this species than on any other.

10. C. Kunzei *Fr.*, Syst. Myc. i. p. 474; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 180.

C. chionea Pers., Myc. Eur. i. 1822, p. 167; *Clavulina Kunzei* Schroet., Pilz. Schles. i. p. 442; *Clavaria Krombholzii* Fr., Epicr. 1836–38, p. 572.

Illustrations: Quélet, Ch. Vosges, 3, tab. 2, fig. 11; Weberbauer, Pilze, tab. 10, fig. 5.

Plants medium-sized, 5–12 cm. high, branched, isolated or gregarious, brittle, ivory to creamy white, base sometimes pink; smell none, taste pleasant. *Stem* usually distinct, 1–2 cm. long, 3–5 mm. thick, but sometimes absent. *Branching* irregularly dichotomous, or irregular, loose or rarely compact; branches erect or spreading, cylindrical or slightly compressed, often elongated, 2–5 mm. thick, even, solid, axils lunate, apices blunt or pointed. *Internal structure* pseudoparenchymatous in transverse section, cells long, 100–300 × 5–8μ. *Basidia* small, 30–35 × 5–6μ; sterigmata 4. *Spores* smooth, hyaline,

globose, minutely apiculate, very small, 3·5–4·5μ in diameter, one-guttulate.

Habitat. In long grass in woods and pastures. Uncommon, but in certain seasons frequent.

This species is very distinct in its beautiful ivory-white colour and loosely branched habit. When well grown it may form tufts 4 to 5 inches high and as much across, but average plants are decidedly smaller. From *C. rugosa* it is distinguished by being branched from the base and by the slender, even (not rugose) branches, and from *C. cristata* by the loose habit, lunate axils, and non-cristate apices. From both it differs in the very small spores.

The type specimens of *C. chionea* are in the Persoon herbarium at Leyden, and Dr. Goethart reported that they agreed in form and size with British specimens of *C. Kunzei* which were submitted to him.

With regard to *C. Krombholzii*, this species was based by Fries on Krombholz, tab. 53, figs. 15, 16, and tab. 54, figs. 18–20, which the latter had referred to *C. Kunzei*. It differed principally in being less branched and in the branches being somewhat flattened. *C. Kunzei* however is well known to be a very variable plant, and it sometimes assumes forms which correspond with the description given for *C. Krombholzii*. No plants have been seen under the latter name which were specifically distinct from *C. Kunzei* or *C. rugosa*.

(*b*) Plants greyish.

11. C. CINEREA *Fr.*, Syst. Myc. i. p. 468; see also Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 184.

C. cinerea Bull., Ch. Fr. p. 204, tab. 354; *C. grisea* Pers., Comment. p. 44; *C. fuliginea* Pers., Myc. Eur. i. 1822, p. 166; *Clavulina cinerea* Schroet., Pilz. Schles. i. p. 443.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 15, fig. 5; Bolton, Hist. Fung. tab. 113 (*C. coralloides*, poor); Cooke, Plain and Easy Acc. Brit. Fung. Ed. i, 1862, tab. 17, fig. 1; Ed. iii, 1876, tab. 10, fig. 2; Greville, Scott. Crypt. Flor. tabs. 64, 321 (vars.); Pat., Tab. Anal. fig. 154; Stevenson, Hymen. ii. p. 290; Weberbauer, Pilze, tab. 11, fig. 2 (*C. grisea*).

Plants branched, very variable in habit, usually 3–5 cm. in height, but sometimes more, solitary or gregarious, greyish or with a faint tinge of purple, rather brittle; smell none, taste mild. *Stem* more or less distinct, thick, short. *Branching* irregular, repeated, uneven, axils usually acute; branches thick or slender, cylindrical or compressed, short, stuffed, erect, wrinkled, apices often toothed. *Flesh* white. *Internal*

structure composed of hyphae 8–10 (–12)μ in diameter, with occasional inflations, slightly septate, loosely filamentous, irregular in transverse section. *Basidia* long, conspicuous, 35–50 (–70) × 6–10μ, contents finely granular; sterigmata 2. *Spores* copious, smooth, hyaline, subglobose or obovate, apiculate at the base, 7–10 × 6–8μ, with one large oil-globule.

Habitat. On the ground in woods, etc. Common and edible.

Very variable in form but known by its grey colour and large spores, the former however being variable in tint. See also the notes under *C. cristata.*

C. CINEREA var. GRACILIS *Rea*, in Trans. Brit. Myc. Soc. vi. 1917, p. 62.

Distinguished from the type form by its larger size, longer and more slender stem, with numerous slender branches and branchlets. Spores 9 × 8μ, with a large central gutta.

Habitat. On bare soil in woods. Caughley, Salop, and Shrawley, Worcestershire.

12. C. GIGASPORA *Cotton*, in Naturalist, 1907, pp. 97–98.

Illustrations: None published.

Plants branched, caespitose but distinct at the base, or solitary, small, up to 3 cm. high, tough, greyish with a tinge of yellow, whitish at base of stem, smell and taste absent. *Stem* slender, not very distinct, 1 cm. long or shorter. *Branching* irregular, sometimes almost palmate, branches erect, occasionally forked, often wrinkled, solid, terete or compressed, much compressed at the acute axils, ultimate branches attenuated, apices blunt. *Internal structure* of densely packed hyphae 4–4·5μ in diameter, forming a firm tough tissue, rather horny when dry. *Basidia* large, 60–70 × 15μ, contents finely granular; sterigmata 4, rather stout, 8–10μ long. *Spores* smooth, hyaline, somewhat pip-shaped, very variable in size, 10–20 × 7–9μ (average 12–16 × 7·5–8μ), contents guttulate, then granular.

Habitat. Amongst moss on a rocky, heathy slope. Only known from the type locality, near Cullingworth, Yorks.

A small, dingy, yellowish-white plant, scarcely overtopping the moss in which it grows. It resembles certain forms of *C. cinerea* and *C. cristata*, but is readily distinguished from either by the exceedingly large spores. The structure also is somewhat exceptional, being composed of very fine, densely matted hyphae, which give rise to unusually large basidia.

(*c*) Plants violet.

13. C. AMETHYSTINA *Fr.*, Syst. Myc. i. p. 472.

Clavaria amethystina Pers., Comment. p. 46; *Coralloides amethystina* Batt., Fung. Agr. Arim. Hist. 1759, p. 22, tab. 1, fig. C; *Ramaria amethystina* Holmsk., Beata ruris, 1790, p. 110; *Clavaria amethystea* Bull., Champ. Fr. tab. 496, fig. 2.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 5, fig. 2; Berk., Outl. tab. 18, fig. 2; Cooke, Plain and Easy Acc. Brit. Fungi, Ed. i, tab. 17, fig. 2; Ed. iii, tab. 11, fig. 3; Cooke, Brit. Edible Fungi, tab. 1, fig. 4; Holmsk., Fung. Dan. i. tab. 28.

Plants branched, 3–4 cm. high, forming small, very compact tufts, lilac or mauve, turning rapidly to yellowish on drying, rather brittle; smell strong, taste tallowy. *Stem* very short, scarcely distinct. *Branching* irregular, axils not flattened; branches thick, 3–5 mm. in diameter, short, cylindrical, not attenuated, erect, smooth, solid, apices blunt. *Flesh* uniform. *Internal structure* of densely interwoven hyphae, frequently septate, cells 50–100 × 8–12 μ, not pseudoparenchymatous in transverse section. *Basidia* rather large, 50–60 × 7–10 μ, sterigmata 2–4. *Spores* smooth, hyaline, globose, with minute basal apiculus, 5–7 μ in diameter.

Habitat. Among grass in woods and pastures. Rare.

Specimens from Rothiemurchus (1900); Alresford, Hants. (W. L. W. Eyre, 1905, 1909); Clare Island (H. C. Hawley, 1910); Dolgelley (C. Th. Green, 1910).

C. amethystina has somewhat the habit of a short thick form of *C. cinerea*, with the deep-coloured forms of which it has by some authors been confused. When once the true plant has been seen, however, there is no difficulty in distinguishing it by its beautiful violet colour (almost as deep as that of *Laccaria laccata* var. *amethystina*), and by its much smaller spores. It is usually much branched, but sometimes almost simple. The only other violet species in Britain, *C. Bizzozeriana*, is very much more slender, and in no way related.

14. C. BIZZOZERIANA *Sacc.*, Syll. vi. 1888, p. 693.

C. tenuissima Sacc., Michelia, i. 1878, p. 436 (*non* Lév.); *C. conchyliata* Allen, in Trans. Brit. Myc. Soc. iii. 1908, p. 92.

Illustrations: Trans. Brit. Myc. Soc. iii. 1908, tab. 8.

Plants branched, very small, not more than 1 cm. in height, solitary or in groups, at first violet, becoming discoloured with age. *Stem* reddish-yellow, pubescent below, with rooting base. *Branching* irregular, dichotomous, the axils of the branches patent; branches very slender, 0·5 mm. thick, erect, apices

blunt. *Flesh* white. *Internal structure* filamentous, filaments 3–4μ in diameter. *Basidia* 15–18 × 3–4μ; sterigmata 2–4. *Spores* hyaline, smooth, globose or subglobose, 2·4–3·5μ in diameter, 1-guttulate.

Habitat. On the ground, under hazel. Rare.

Easily recognised by the very small size and the violet colour of the branches, which are "irregular and divaricate with somewhat digitate ends."

It is regrettable that the name *C. conchyliata* must be dropped in favour of *C. Bizzozeriana*. Mr. Allen submitted specimens of his plant to Kew in 1907, and was informed that it was apparently an undescribed species. Specimens of the same species were received from Switzerland in 1912 and it was subsequently discovered that the plant was *C. Bizzozeriana*, a species described by Saccardo in 1888.

The species is very rare in Britain, but material has been forwarded on two occasions by Dr. J. S. Bayliss Elliott.

(*d*) Plants clear yellow.

15. C. CORNICULATA *Fr.*, Syst. Myc. i. p. 471.

C. corniculata Schaeff., Icon. Fung. tab. 173; *C. muscoides* Linn., Spec. Plant. 1753, p. 1183; *Ramaria muscoides* Holmsk., Beata ruris, 1790, p. 87; *Clavaria furcata* Pers., Comment. p. 52.

Illustrations: Bolton, Hist. Fung. tab. 114 (poor); Fl. Dan. tab. 775, fig. 3; Holmsk., Fung. Dan. i. tab. 21; Pat., Tab. Anal. fig. 564; Schaeff., tab. cit.

Plant branched, 3–4 cm. high, gregarious, tough, clear egg-yellow; smell none, taste mild. *Stem* short, downy at the base. *Branches* slender, two or three times forked, erect, even, solid, axils lunate or acute, often compressed, apices attenuated, not pointed. *Flesh* slightly paler than the exterior. *Internal structure* composed of filaments running parallel to the axis, not interwoven but very easily separating and becoming twisted, 4–8μ thick (average 5–7μ), fairly frequently septate with cells 100–200μ long, not pseudoparenchymatous in transverse section. *Basidia* distinct, about 50μ long, vacuolate or clear; sterigmata 4, 10μ long, fairly erect. *Spores* white in the mass, smooth, subglobose, apiculate, hyaline, 6–7μ in diameter, guttulate.

Habitat. Amongst grass, especially in fields. Common.

This is the commonest of the branched yellow species. It varies in form in accordance with its surroundings, but the clear yellow colour and beautiful globose spores, 6–7μ in diameter, clearly separate it from other species. The height

of the plant is determined by the nature of the surrounding vegetation and conditions of exposure. In long damp grass it grows loosely and is frequently four inches in height, whereas in shorter grass and more open surroundings it is shorter and more compact; whilst on exposed hills and downs the dwarf form, var. *pratensis*, is produced. The latter is a very common plant, and may occasionally be found in vast quantities.

C. corniculata was formerly known in all British works as *C. muscoides*. The change in name is necessitated by the International Rules of Nomenclature. It was agreed that the starting-point for the nomenclature of the Hymenomycetes should be Fries' Systema Mycologicum, 1821–1832, and as Fries there adopts the names *C. corniculata* and *C. pratensis* these stand, in spite of the fact that he later changed his mind and adopted the Linnaean names *C. muscoides* and *C. fastigiata*.

C. CORNICULATA *Fr.* var. PRATENSIS *Cotton et Wakef.*

Clavaria pratensis Fr., Syst. Myc. i. p. 471; Pers., Comment. p. 51; *C. fastigiata* Linn., Spec. Plant., 1753, p. 118; *Ramaria fastigiata* Holmsk., Beata ruris, 1790, p. 90; *Clavaria muscoides* var. *fastigiata* Cotton, in Trans. Brit. Myc. Soc. iii. 1909, p. 181.

Illustrations: Bolton, Hist. Fung. tab. 112, fig. 2 (poor); Bull., Champ. Fr. tab. 358, figs. D, E; Holmsk., Fung. Dan. i. tab. 22; Flor. Dan. tab. 836, fig. 2; Pers., Comment. tab. 4, fig. 5.

Plants tough, very much branched, branches crowded, of equal length and forming a level top. Colour the same as that of the typical form.

Habitat. In short grass in exposed situations.

This plant was formerly known as *C. muscoides* var. *fastigiata* (= *C. fastigiata* L.). For remarks as to habitat, etc., see notes under typical form.

(*e*) Plants pale umber.

16. C. UMBRINELLA *Sacc.*, Syll. vi. 1888, p. 695; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 181.

C. umbrina Berk., Outlines, 1860, p. 279.

Illustrations: Berk., loc. cit. tab. 18, fig. 4 (very poor); Cotton, loc. cit. tab. 11, fig. E (spores).

Plants slightly branched, small, 2–2·5 cm. high, isolated or caespitose, pale brown; smell none, taste pleasant. *Stem* sometimes thick and minutely velvety, but often absent, a number of slender branches arising close together from the base. *Branching* irregularly dichotomous, axils somewhat flattened; branches slender, erect, cylindrical, 1–2 mm. thick,

even, solid. *Internal structure* composed of loosely and slightly interwoven filaments, 5–10μ in diameter (average 7–8μ). *Basidia* small, 35–40 × 6–7μ, contents finely granular; sterigmata 4. *Spores* hyaline, smooth, pip-shaped, laterally apiculate, 4–5 × 4μ or 5–6 × 3–4μ, usually guttulate.

Habitat. On lawns. Uncommon.

C. umbrinella is a well-marked and somewhat uncommon species. It is distinguished by its short branched habit, like that of *C. corniculata* var. *pratensis*, and by its pale brown colour.

Owing partly to the poorness of Berkeley's figure a good deal of uncertainty has existed as to its identity. Part of the original gathering which exists at Kew, however, shows the characteristic pip-shaped spores. The specimens taken together with Berkeley's description and his rider that "The habit is that of *C. fastigiata*" leave no doubt as to the plant he had in view.

B. Plants Simple.

1. *Plants tufted.*

17. C. VERMICULARIS *Fr.*, Syst. Myc. i. p. 484; Cotton in Trans. Brit. Myc. Soc. iii. 1907, p. 32.

C. fragilis Holmsk. p.p., Beata ruris, 1790, p. 7; *C. vermiculata* Scop., Flor. Carniol. ii. 1772, p. 483.

Illustrations: Cooke, Plain and Easy Acc. Brit. Fungi, Ed. i, 1862, tab. 17, fig. 4; Ed. iii, 1876, tab. 6, fig. 3; Cooke, Brit. Edible Fungi, tab. 4, fig. 15; Holmsk., Fung. Dan. i. tab. 2, fig. *f*; Stevenson, Hymenomyc. ii. p. 298.

Plants unbranched, densely tufted, somewhat flexuous, brittle, white, about 4–6 cm. high. *Clubs* cylindrical, sometimes twisted and compressed, apex acute, smooth, fragile, becoming hollow. *Stem* not distinct. *Internal structure* of parallel, septate hyphae, with rather long cells, pseudoparenchymatous in transverse section, central cells 10–15μ in diameter, with smaller cells intermixed. *Basidia* small, 30 × 6–7μ; sterigmata 4. *Spores* smooth, hyaline, subglobose, minutely apiculate at the base, 3–5 × 3–4μ.

Habitat. In meadows, etc. Common, especially early in the autumn.

Easily distinguished among the white species by the densely tufted habit, very fragile clubs and small spores.

18. C. FUMOSA *Fr.*, Syst. Myc. i. p. 483.

C. fumosa Pers., Obs. Myc. i. p. 31; Comment. p. 76.

Illustrations: Krombholz, Abb. und Beschreib. tab. 53, fig. 18.

Plants unbranched, tufted, very brittle, 4–8 cm. high; smell none; taste marked, pleasant. *Clubs* white when young, later pale mouse-grey, tips brown, base whitish, cylindrical or clavate, sometimes furrowed, surface smooth or slightly furrowed, becoming hollow with age, apex blunt or acute. *Stem* not at all or scarcely distinct from club. *Flesh* white, the hymenial layer easily peeling off. *Internal structure* of short cylindrical cells, 30–50 × 10–15 μ, parallel to the long axis of the club; structure in transverse section pseudo-parenchymatous, like that of *C. vermicularis*. *Basidia* inconspicuous, 35 × 6–7 μ; sterigmata 2–4, short. *Spores* smooth, hyaline, cylindric-ellipsoid or somewhat pip-shaped with minute oblique apiculus, 6–8 × 3–4 μ, contents often guttulate or granular.

Habitat. Amongst grass in fields. Not common.

This species has the dense tufted habit of *C. vermicularis* and occurs in similar situations, but is grey in colour. If there is any doubt the much larger spores at once distinguish it.

19. C. FUSIFORMIS *Fr.*, Syst. Myc. i. p. 480.

C. fusiformis Sow., Col. Fig. tab. 234; *C. fasciculata* Pers., Comment. p. 72; *C. ceranoides* Pers., Syn. p. 594.

Illustrations: Bolton, Hist. Fung. tab. 110 (as *C. pistillaris*); Cotton in Trans. Brit. Myc. Soc. iii. 1909, tab. 11, fig. A; Hussey, Illustr. Brit. Mycol. i. tab. 18; Pat., Tab. Anal. fig. 565; Sowerby, loc. cit. tabs. 234, 235 (the latter figure the basis of *C. ceranoides* Pers.).

Plants simple or very rarely branched, densely tufted, connate at the base, 5–8 cm. high, clear canary-yellow; smell none when fresh, taste bitter. *Clubs* elongated, spindle-shaped, tips acute, often becoming hollow and compressed. *Stem* not distinct. *Flesh* whitish, as in *C. inaequalis*. *Internal structure* of fine filaments, 4–6 μ thick, more or less interwoven, walls sometimes rough; occasional hyphae with dark yellow contents. Mature *basidia* hyaline, 35–40 × 6·8 μ; sterigmata 4, slightly curved. *Spores* globose, smooth, minutely apiculate, 5–7 (–8) μ in diameter, at first yellow, then colourless.

Habitat. Amongst grass in the open and in woods. Common.

Known amongst the simple yellow species by the densely tufted habit, the canary-yellow colour and the bitter taste.

2. *Plants solitary or in small groups.*

(*a*) Plants white.

20. C. ACUTA *Fr.*, Syst. Myc. i. p. 485; Cotton in Trans. Brit. Myc. Soc. iii. 1907, p. 31.

C. acuta Sow., Col. Fig. tab. 333; ? *C. falcata* Pers., Comment. p. 81, tab. 1, fig. 3.

Illustrations: Sowerby, loc. cit.

Plants unbranched, solitary or in small groups, 3–7 cm. high, glistening white; smell none, taste distinct, pleasant. *Clubs* slender, about 2–3 mm. wide, cylindrical or compressed, smooth, becoming hollow, very brittle, apex acute or obtuse. *Stem* more or less distinct from the club, variable in length, 1–2 cm., white. *Internal structure* of frequently septate hyphae, running parallel to the long axis of the club, 5–12 (–30) μ in diameter, average 10 μ, pseudoparenchymatous in transverse section. *Basidia* conspicuous, small, 30–35 × 7–8 μ, contents granular; sterigmata 2–4, slightly divergent. *Spores* subglobose, smooth, hyaline, minutely apiculate, 7–10 × 6–9 μ (average 8–9 × 7–8 μ), contents granular, guttulate when young.

Habitat. Amongst grass in woods, on shady lawns, etc., and often on the soil of plant pots in greenhouses. Not common.

Clavaria acuta has probably often been referred to *C. fragilis*, which is however in part a synonym of *C. vermicularis*. This species is distinguished from *C. vermicularis* by its solitary habit of growth, distinct stem, and large spores. Its frequent occurrence in greenhouses has been noted by several writers.

21. C. RUGOSA *Fr.*, Syst. Myc. i. p. 473.

C. rugosa Bull., Ch. Fr. p. 206, tab. 448, fig. 2; *C. damicornis* Schrank, Baiersche Flor. ii. 1789, p. 666; *C. elegans* Bolt., Hist. Fung. tab. 115; *C. laciniata* Schaeff., Icon. Fung. tab. 291; *C. canaliculata* Fr., Obs. Myc. ii. p. 294; *Clavulina rugosa* Schroet., Pilz. Schles. i. p. 442.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 15, fig. 4; Berk., Outlines, tab. 18, fig. 3; Bolton, loc. cit.; Cooke, Plain and Easy Acc. Brit. Fung. Ed. i, tab. 17, fig. 3; Ed. iii, tab. 6, fig. 2; Cooke, Brit. Edible Fung. tab. 9, fig. 32; Greville, Scott. Crypt. Flor. tab. 328; Pers., loc. cit.; Sowerby, Col. Fig. tab. 278, lower figs. (as *C. coralloides*).

Plants simple or slightly irregularly branched, solitary or gregarious, 5–10 cm. high, white or pallid, rather tough. *Clubs* thickened upwards, up to 1 cm. thick, longitudinally wrinkled, solid, apex blunt. *Stem* not distinct. *Internal structure*

uniform, somewhat dense, but looser in centre, of much interwoven, frequently septate hyphae, 8–10μ in diameter. *Basidia* long, conspicuous, up to 60μ long, 5–6μ wide, contents granular; sterigmata 2. *Spores* subglobose, smooth, hyaline, with basal apiculus, and a large guttule, 9–11 × 8–9μ (or 9–10μ in diameter).

Habitat. In woods and shady spots. Common.

This species varies in habit from simple to very branched forms, and the surface may be exceedingly rugose to almost smooth. It is generally recognisable, however, by the distinct, irregular, longitudinal wrinkles, and the large spores.

C. RUGOSA var. FULIGINEA *Fr.*, Hym. Eur. p. 669; Rea in Trans. Brit. Myc. Soc. vi. 1917, p. 62.

This variety is unknown to us, it is said to differ from the type in the dark, sooty colour of the clubs and flesh. It has been collected recently in England by Mr. Carleton Rea.

Habitat. On the ground, Caughley Wood, Salop, 1917.

22. C. ASTEROSPORA *Pat.*, Tab. Anal. ser. 2, 1886, p. 28, fig. 568.

Illustration: Pat., loc. cit.

Plants simple, slender, gregarious, 2–3 cm. high, pure white. *Clubs* cylindrical, fragile, smooth, hollow, apex blunt or pointed. *Stem* slender, greenish at the base, not markedly distinct from the club. *Internal structure* pseudoparenchymatous in transverse section. *Basidia* clavate, 30–40 × 8μ; sterigmata 4. *Spores* hyaline, globose, with long, scattered spines, spore-body 7–8μ in diameter.

Habitat. On bare soil, rare. Specimens from Haslemere (A. D. C., 1905; E. M. W., 1913).

This species is distinguished from other white simple forms by the globose, distinctly spiny spores. *C. tenerrima* Mass. et Crossl. is similar in habit, but the spores are described as granular. The latter has not been met with since it was described, and is therefore listed here among the doubtful species.

(*b*) Plants drab or greyish.

23. C. TENUIPES *Berk. et Br.*, in Ann. Nat. Hist. ser. 2, ii. 1848, p. 266, No. 369; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 182.

Pistillaria tenuipes Mass., Brit. Fung. Flor. i. p. 91.

Illustrations: Berk. et Br., loc. cit. tab. 9, fig. 2; Cooke, Handbook Brit. Fung. i. p. 336; Mass., Brit. Fung. Flor. i. p. 74, figs. 6, 7.

Plants simple, isolated or in small groups, small, pale grey to drab in colour; smell none; taste "mushroom-like." *Clubs* 3–6 cm. high, 2–10 mm. wide, clavate or cylindrical, often compressed, smooth or slightly rugulose, hollow when old, apex blunt. *Stem* more or less distinct, slender, 1–2 cm. long, 2–3 mm. wide. *Flesh* uniform in colour. *Internal structure* of loosely packed, unbranched hyphae, 8–10μ (rarely 15–20μ) in diameter, cells 50–150μ long. *Basidia* rather small, 30–40 × 7–9μ, contents granular; sterigmata 4, erect. *Spores* smooth, hyaline, ovoid, with a minute oblique basal apiculus, 7–9 × 4–5μ (average 8 × 4μ), contents guttulate, then granular.

Habitat. Amongst short grass, especially in heathy places.

The plant is readily recognised by its greyish or drab colour, and by the more or less thickened, fleshy club and slender stem. The name has been formerly often wrongly applied to *C. acuta*, which differs in its slender, very fragile, snow-white sporophores. The stem in some specimens is sharply separated from the spore-bearing surface; in others the transition is not so abrupt. On account of the somewhat tough texture and distinct stem the plant has been placed in Pistillaria, a genus of minute, epiphytic plants. It is however a genuine Clavaria.

24. C. Crosslandii *Cotton*, in Naturalist, 1912, p. 86.

Illustrations: None published.

Plants small, unbranched, isolated or fasciculate, greyish-white or grey, becoming darker with age; smell and taste slight, pleasant. *Clubs* very slender, brittle, 2–3 cm. high, 1–3 mm. thick, pruinose, cylindrical, apex usually pointed. *Stem* hardly distinct. *Flesh* somewhat darker than the hymenium. *Internal structure* pseudoparenchymatous in transverse section, cells 5–8μ in diameter. *Basidia* 20–25 × 4–5μ, contents granular; sterigmata 4, erect. *Spores* hyaline, smooth, pip-shaped, 4–5 × 2·5–3μ.

Habitat. In short grass. Known only from the type locality, Mulgrave Woods, Yorks. (C. Crossland and W. N. Cheesman, 1910–1911).

The grey colour and small size are good field characters by which to recognise the present species. From the drab-coloured *C. tenuipes* it is distinguished by its slender, brittle clubs, and from *C. fumosa* by its fasciculate instead of densely tufted habit. *C. acuta*, which is similar in size, habit, and texture, differs in the complete absence of the grey tinge. Furthermore the small basidia and spores mark off *C. Crosslandii* from allied species. It approaches *C. affinis* Pat. et

Doass., but the latter differs, according to the published description (no type is preserved), (i) in the distinct stem; (ii) in becoming yellow on drying; (iii) in the slightly larger, punctulate spores.

(*c*) Plants reddish or purple.

25. C. ROSEA *Fr.*, Syst. Myc. i. p. 482.

C. rosea Dalman, in Vet. Acad. Handl. 1811, p. 157.

Illustrations: Fries, Obs. Myc. ii. tab. 5, fig. 2; Krombh., Abbild. u. Beschreib. tab. 53, fig. 21.

Plants simple, solitary or in groups of 3–7, 2–4 cm. high, fragile, bright rose-pink; taste and smell none. *Clubs* slender, cylindrical or compressed, equal or tapering upwards, smooth, solid, 2–5 mm. thick, apex blunt or pointed. *Stem* fairly distinct, paler, sometimes yellowish. *Flesh* whitish, deep rose beneath the hymenium. *Internal structure* of frequently septate, irregular hyphae, 7–12 μ in diameter, semi-parenchymatous in transverse section; crystals sometimes present. *Basidia* conspicuous, 35–40 × 7–10 μ, granular or guttulate, sterigmata 4, erect. *Spores* copious, smooth, hyaline, ovoid or broadly elliptical, 7–10 × 5–6 μ.

Habitat. Amongst grass, moss, etc. Rare. Specimens from near Hebden Bridge (C. Crossland, 1895–97); Morpeth (C. H. Spencer Perceval, 1908, 1909, 1910); Halifax (C. Crossland, 1908); Forres (1912); Selby (1918).

Easily distinguished from other British species by the bright, rose-pink colour.

26. C. PURPUREA *Fr.*, Syst. Myc. i. p. 480.

C. purpurea Müller, in Flor. Dan. tab. 837, fig. 2.

Illustrations: Flor. Dan. tab. cit.

Plants unbranched, caespitose, up to 12 cm. high, somewhat tough, purplish brown or dark chocolate; smell none. *Clubs* slender, 1–2 mm. thick, flattened, smooth, solid, apex acute, paler. *Stem* hardly distinct, whitish at the base. *Flesh* not distinct. *Internal structure* of irregular hyphae, cells 50–60 μ long, 3–5 μ in diameter, or 7–9 μ towards the centre of the club, pseudoparenchymatous in transverse section. *Basidia* small 25–30 × 7–8 μ, guttulate; sterigmata 4, erect. *Spores* hyaline, smooth, oval, 7–8 × 4–5 μ, contents granular.

Habitat. Amongst grass. Very rare. Small specimen from Mulgrave Woods, Yorkshire (C. Crossland, 1910).

Distinguished by its dark, purplish-brown colour.

27. C. INCARNATA *Weinm.*, Hymeno- et Gasteromycetes, 1836, p. 510.

Illustrations: None published.

Plants simple, solitary or gregarious, fragile, 2–3·5 cm. high, flesh-coloured to pale chocolate; smell slight, pleasant. *Clubs* slender, 2–2·5 mm. thick, cylindrical or compressed, even or slightly rugose, hollow, apex blunt. *Stem* more or less distinct. *Flesh* coloured, pale or darker than the club. *Internal structure* of frequently septate hyphae, loosely interwoven, with trumpet-shaped expansions in the sub-hymenial layer, cells 50–100 × 5–10 μ, pseudoparenchymatous in transverse section. *Basidia* 35–40 × 7–8 (–10) μ, contents finely granular; sterigmata 4, erect. *Spores* abundant, hyaline, smooth, ovoid, 7–10 × 6–8 μ (average 8 × 5 μ), contents granular.

Habitat. On the ground. Very rare. Specimens from Whitby and Halifax (C. Crossland, 1908); ? Haslemere (E. M. W., 1913).

Distinguished from *C. purpurea* by the paler colour, smaller size, and slightly larger spores. *C. rosea* differs in its brighter, rose-pink colour.

(*d*) Plants yellow.

28. C. INAEQUALIS *Fr.*, Syst. Myc. i. p. 481; Cotton in Trans. Brit. Myc. Soc. ii. 1906, pp. 163–165, and iii. 1907, p. 33.

C. inaequalis Müller, Fl. Dan. tab. 836, fig. 1; *C. polymorpha rufa* Müll. Fl. Dan. tab. 775, fig. 1; *C. rufa* Pers., Comment. p. 71; *C. fasciculata* Villars, Hist. Pl. Dauph. iv. 1789, p. 1052; *C. bifurca* Bull., Ch. Fr. tab. 264; *C. angustata* Pers., Comment. p. 72; *C. vermiculata* Sow., Col. Fig. tab. 253, p.p.; *C. dissipabilis* Britz., Hymenomycet. aus Südbayern, 1885, p. 289; *C. similis* Boud. et Pat., Journ. de Bot. ii. 1888, p. 446.

Illustrations: Flor. Dan. tab. 836, fig. 1; Boud. et Pat., loc. cit. tab. 8, fig. 1; Britzelmayr, loc. cit. fig. 28; Bulliard, loc. cit.; Cotton in Trans. Brit. Myc. Soc. iii. tab. 11, fig. B (spores); Greville, Scott. Crypt. Flor. i. tab. 37 (*C. fragilis*); Massee, Brit. Fung. Flor. i. p. 74, fig. 4; Pers., Comm. tab. 1, fig. 3 *bis* (*C. angustata*); Sowerby, Col. Fig. tab. 253 (lower figs.).

Plants simple, or very rarely with one or two branchlets, 4–7·5 cm. high, usually in small groups but occasionally single. *Clubs* cylindrical or flattened, smooth or with one or more furrows, bright yellow to rich orange, apex obtuse or pointed. *Stem* not distinct. *Flesh* whitish, fibrous. *Basidia* conspicuous,

clavate, yellowish, 30–40 × 6–8μ; sterigmata 4, more or less erect. *Spores* hyaline, white or slightly ochraceous in the mass, subglobose, sharply warted, 5–6 (–8)μ in diameter.

Habitat. Amongst grass in woods, parks, lawns, etc. Common.

This is by far the most frequent of the yellow simple Clavarias, being found in short grass in a variety of situations every season. It may be distinguished at once from all other yellow species by its subglobose, spiny spores.

As pointed out in the notes in Trans. Brit. Myc. Soc. ii. p. 163, *C. dissipabilis* Britz. is merely a synonym of *C. inaequalis*. The only justification for Britzelmayr's describing his plant as a new species was Karsten's statement that the spores of *C. inaequalis* were smooth and elliptical. This was an error, as the examination of material in herbaria, including Karsten's own specimens, clearly shows. It is possible that a species with smooth elliptical spores occurs on the Continent, but if so it is obviously very rare and cannot be regarded as representing the old and well-known *C. inaequalis*.

Dark forms of this species, almost orange in colour, sometimes occur, and these represent the *C. polymorpha rufa* (= *C. rufa* Pers.) of the Flora Danica. (See Trans. Brit. Myc. Soc. iii. p. 33.)

29. C. STRAMINEA *Cotton*, in Trans. Brit. Myc. Soc. iii. 1910, p. 265.

Illustrations: Cotton, loc. cit. tab. 11, fig. D (given in error as *C. persimilis*).

Plants small, unbranched, isolated or caespitose, straw-coloured, becoming brownish with age; smell and taste not marked. *Clubs* slender, 3–5 cm. high, 3–4 mm. thick, cylindrical or somewhat compressed, smooth, brittle, apex usually acute. *Stem* usually very distinct, cinnamon-yellow. *Flesh* somewhat darker than the hymenium. *Internal structure* pseudoparenchymatous in transverse section. *Basidia* rather large, 40–60 × 7–9μ, contents granular, sterigmata 4. *Spores* hyaline, smooth, globose, with a minute basal apiculus, 5–7μ in diameter, contents granular.

Habitat. In short grass. Rare. Specimens from Erringden, near Halifax (C. Crossland, 1905); Carlisle (Miss D. Graham, 1908–1909); Chatsworth (A. D. C., 1909); Broseley, Salop (G. Potts, 1909); Clare Island (A. D. C., 1910); Sandsend, Yorks. (C. Crossland, 1912); Haslemere (E. M. W., 1913).

C. straminea differs from *C. argillacea* in its smaller size, and pointed cylindrical clubs, and also in its globose spores. In both species the spore-bearing surface is paler in colour than

the stem, and is more or less clearly separated from it. In *C. argillacea* the stem is yellow or greenish-yellow, whereas in *C. straminea* it becomes a brownish-red or cinnamon, and this colour is liable, especially on handling, to spread over the whole surface of the club.

C. flavipes Pers., in Fries, Syst. Myc. i. p. 483, might possibly refer to this species, but no specimen exists, and its identity cannot be determined from the description and figures quoted.

30. C. ARGILLACEA *Fr.*, Syst. Myc. i. p. 482.

C. argillacea Pers., Comment. p. 74; *C. ericetorum* Pers., Obs. Myc. ii. 1799, p. 60.

Illustrations: Boudier, Icon. Mycol. i. tab. 175; Fries, Obs. Myc. ii. tab. 5, fig. 3; Pat., Tab. Anal. fig. 585, *non* 587.

Plants simple, gregarious, 2–5 cm. high, pale greenish-yellow, fragile; smell none, taste like tallow. *Clubs* cylindrical or flattened, with one or more grooves, surface often minutely channelled, apex blunt. *Stem* distinct, yellowish. *Internal structure* almost pseudoparenchymatous in transverse section, even when old; cells regular, 10–14μ in diameter, with small narrow filaments (4–5μ in diameter) between; segments 50–70μ long towards the margin, but up to 200–300μ in the centre. *Basidia* conspicuous, about 70μ long, contents granular, sterigmata 4. *Spores* smooth, hyaline, cylindric to elliptical with a minute lateral basal apiculus, 10–11 × 5–6μ (or sometimes 10–14 × 6–7μ), contents granular.

Habitat. In heathy places. Not uncommon.

This species is a typical plant of heather moors and similar heathy places, on which it at times occurs in profusion and occasionally in company with *C. tenuipes*. The only species with which it is likely to be confused is *C. straminea*, which as stated in the remarks under that species differs in its globose spores and other characters.

31. C. LUTEO-ALBA *Rea*, in Trans. Brit. Myc. Soc. ii. 1903, p. 66; Cotton, ibid. iii. 1907, pp. 30–31, 183.

Illustrations: Trans. Brit. Myc. Soc. ii. 1903, tab. 3, fig. B; Ibid. iii. 1907, tab. 11, fig. C (spores).

Plants simple, isolated or in two's or three's, small, 3–5 cm. high; smell none, taste like tallow. *Clubs* very slender, 1·5–3 mm. thick, apricot-yellow with apex whitish, cylindrical or slightly compressed, smooth, solid, usually attenuated, apex acute or obtuse. *Stem* not sharply marked, often becoming more distinct on drying. *Flesh* orange-yellow. *Internal structure* not pseudoparenchymatous in transverse section, but composed of loosely packed longitudinally running fila-

ments, 5–6μ in diameter, containing orange-coloured granules. *Basidia* small, 25–30 × 5–7μ, contents slightly granular; sterigmata 4, erect. *Spores* hyaline, smooth, ovoid or slightly pip-shaped, not apiculate, 6–8 × 3–4μ (average 6–7 × 3μ).

Habitat. In short grass, on mossy banks, etc. Not uncommon.

The species is distinguished from *C. inaequalis* by its small size and apricot-yellow clubs, with the apex not infrequently white. The flesh also is practically identical in colour with the exterior of the club, whereas in *C. inaequalis* the flesh is whitish. The smooth ovoid spores moreover distinguish it. On drying the plant rapidly loses its apricot hue, and finally becomes pale ochraceous, the stem usually retaining the colour longer than the club, and becoming twisted. The white apex from which the plant takes its name is more marked in some cases than in others, and may be altogether absent; it appears to be more obvious in the field, and disappears on drying.

Some remarkably large specimens were found growing amongst holly leaves at Haslemere. These plants grew in clusters or singly, with the habit and markings of *C. rugosa.* The spores were 7–10 × 4–5μ (average 8 × 4μ), slightly larger than those of typical *C. luteo-alba,* but the colour of the clubs and flesh was normal.

32. C. PERSIMILIS *Cotton,* in Trans. Brit. Myc. Soc. iii. 1909, p. 182.

Illustrations: None published.

Plants small unbranched, isolated or fasciculate, orange-yellow to orange, becoming darker on drying. *Clubs* slender, 3–5 cm. high, 2–3 mm. thick, cylindrical or somewhat compressed, apex usually acute. *Stem* not sharply defined. *Flesh* pale. *Internal structure* composed of loosely packed, longitudinally running filaments 3–6μ in diameter, not pseudoparenchymatous in transverse section. *Basidia* small, 30–35 × 7–8μ, contents granular; sterigmata 4, erect. *Spores* smooth, hyaline, subglobose to oblong, with a conspicuous lateral oblique apiculus, 5–6 × 4μ, guttulate.

Habitat. In short grass. Not uncommon.

The present species is very similar to *C. luteo-alba* Rea, and difficult to distinguish from it in the field. An unfailing character is found in the spore, which is subglobose to oblong with a very well-marked oblique apiculus, and not ovoid and non-apiculate as in *C. luteo-alba.* It differs also in other characters, namely, in the different shade of colour when fresh, the absence of a white tip, and in becoming dark orange on drying.

(*e*) Plants ochraceous to brownish.

33. C. PISTILLARIS *Fr.*, Syst. Myc. i. p. 477.

C. pistillaris Linn., Flor. Suec. p. 456, No. 1266 (1755); *Fungus clavatus* Bocc. ex Fries, loc. cit.; *C. major* Mich., Gen. Plant. tab. 87, fig. 1; *C. herculeana* Lightfoot, Fl. Scot. ii. 1777, p. 1056; Pers., Comment. p. 63; *C. pulvinata* Pers., Comment. p. 65.

Illustrations: Numerous. Atkinson, Mushrooms, p. 202, fig. 203; Bulliard, Ch. Fr. tab. 244; Hussey, Illustr. Brit. Mycol. i. tab. 62; Massee, Brit. Fung. Flor. i. p. 74, fig. 8; Sowerby, Col. Fig. tab. 277; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24; Weberbauer, Pilze, tab. 11, fig. 3.

Plants simple, solitary, clavate or obovate, variable in size, 10–30 cm. high, 2·5–5 cm. thick at the widest part. *Clubs* minutely velvety, whitish then dingy ochraceous, finally dusky brown, stuffed. *Stem* not distinct. *Flesh* whitish, loose and cottony in the centre. *Basidia* about 70μ long, with 2–4 sterigmata. *Spores* smooth, ochraceous in the mass, almost hyaline by transmitted light, elliptic-oblong, with oblique basal apiculus, 12–16 × 7–8μ.

Habitat. On the ground in woods. Rather rare and sporadic.

Easily distinguished by the large, thick, club-shaped sporophores.

34. C. LIGULA *Fr.*, Syst. Myc. i. p. 477.

C. ligula Schaeff., Icon. Fung. tab. 171; *C. caespitosa* Wulf., in Jacq. Misc. 2, 1781, p. 98, tab. 12, fig. 2; *C. pulvinata* Pers., Comment. p. 65; *C. luteola* Pers., Comment. p. 66.

Illustrations: Flor. Dan. tab. 837, fig. 1; Schaeff., loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24 B, fig. 1; Weberbauer, Pilze, tab. 11, fig. 4.

Plants simple, clavate, 5–10 cm. high, up to 1·25 cm. thick above, much narrowed and downy towards the base, ochraceous with a rufescent tinge, fragile, apex rounded. *Stem* not distinct from the club. *Flesh* solid. *Basidia* conspicuous, 40 × 6–8μ; sterigmata 4. *Spores* smooth, hyaline, cylindrical or very narrowly elliptical, with a curved basal apiculus, 11–14 × 4μ.

Habitat. Attached by the downy base to leaves, twigs, etc., lying on the ground in woods. Very rare. Specimen from Duncombe Park near Helmsley (Y. N. U. Foray, Sept. 1903).

This species is allied to *C. pistillaris*, but differs in the flattened and much smaller clubs and pale colour. It is apparently very rare in Britain as no specimens have been received during

the past 15 years. Specimens, however, were forwarded by Mr. C. G. Lloyd from Sweden and Mr. W. B. Allen from Germany.

35. C. FISTULOSA *Fr.*, Syst. Myc. i. p. 479; Lind in Ann. Myc. v. 1907, p. 272.

C. fistulosa Holmsk., Beata ruris, 1790, p. 15, tab. 6; *C. pilipes* Müll., Flor. Dan. tab. 1076, fig. 1; *C. Ardenia* Sow., Col. Fig. tab. 215; *C. strigosa* Schum., Enum. Pl. Saell. 1801, p. 403; *C. macrorhiza* Sw., Vet. Ak. Handl. 1811, tab. 6, fig. 1.

Illustrations: Holmskiold, Fung. Dan. i. 1799, tab. 6; Harper in Mycologia, x. 1918, tabs. 3, 4, figs. A, B; Flora Danica, tab. 1076, fig. 1, tab. 1256; Sowerby, loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24 B, fig. 2.

Plants simple, solitary or two to three together, erect, tough, narrowly clavate, 5–8 cm. high or more; smell and taste none. *Clubs* at first yellowish, then date-brown, cylindrical or clavate, often twisted, smooth, hollow with age, occasionally branching at the apex. *Stem* with whitish fibrils. *Flesh* not distinct in colour. *Internal structure* characterised by possessing a system of laticiferous hyphae, unseptate, frequently branched, 6μ in diameter, contents granular. *Basidia* conspicuous, about 40μ long, contents finely granular; sterigmata 4, erect. *Spores* hyaline, smooth, pip-shaped, with often irregular outline, 10–17 × 7–9μ (average 13–15 × 8μ), contents guttulate or granular.

Habitat. On fallen branches lying amongst dead leaves. Rare.

According to Lind, in Denmark this species occurs chiefly on branches of beech, whereas *C. contorta* is usually on alder. Harper, however, finds *C. fistulosa* always on sticks buried amongst leaves in coniferous woods. Both writers agree that the spores of *C. fistulosa* are smaller than those of *C. contorta*, and this observation is borne out in the British specimens examined.

36. C. CONTORTA *Fr.*, Syst. Myc. i. p. 478; Lind in Ann. Myc. v. 1907, p. 272; Cotton in Trans. Brit. Myc. Soc. ii. 1906, p. 165, and iii. 1910, p. 266.

C. contorta Holmsk., Beata ruris, 1790, p. 29, tab. 12; *Tremella ferruginea* Schum., Enum. Pl. Saell. 1801, p. 443.

Illustrations: Holmskiold, loc. cit. tab. 12; Flora Danica, tab. 1852, fig. 1; Harper in Mycologia, x. 1918, tab. 4, fig. C; Boudier in Bull. Soc. Myc. Fr. xxxiii. 1917, tab. 1, fig. 5.

Plants erumpent, 2–3 cm. high, contorted, irregularly branched; smell and taste none. *Clubs* pale yellowish-drab,

darker when moist, fairly tough; branches 4–6 mm. thick, short, blunt, wrinkled, not attenuated, at length hollow. *Stem* not distinct. *Internal structure* in longitudinal section of long cells 10–15μ wide, with narrower elements on either side; latex-tubes present. *Basidia* rather large, very distinct, 50 × 10μ, contents finely granular; sterigmata 4. *Spores* hyaline, smooth, ovate or pip-shaped, pointed at the base, 17–23 × 8–10μ (average 19 × 9μ), contents vacuolate.

Habitat. On branches of *Alnus*. Rare.

As pointed out in the notes in these Transactions referred to above, von Höhnel regards *C. contorta* as a morbid form of *C. fistulosa*, but this statement has been criticised by Lind. Lind's arguments appear to be confirmed by what is known of British specimens. In the paper quoted he gives a tabular comparison of the differences between *C. contorta* and *C. fistulosa*, stating that he knows both species well and finds no intermediate forms. The chief points of distinction in *C. contorta*, besides its dwarf, fasciculate habit, are its paler, more greyish colour, entirely smooth club, covered everywhere with the hymenium, its occurrence on dead branches still remaining on the tree, as well as on fallen ones, preference for *Alnus incana*, and larger spores.

37. C. JUNCEA *Fr.*, Syst. Myc. i. p. 479; Harper in Mycologia, x. 1918, p. 56.

C. juncea Fr., Obs. ii. p. 291; *C. cylindrica* Tode, in Schrift. Naturf. Freund. Berl. iv. 1783, p. 166; *C. triuncialis* Pers., Comment. p. 82; *C. triuncialis* f. *juncea* Alb. et Schw., Consp. Fung. p. 289; *C. hirta* Vahl, Flor. Dan. tab. 1257; *Typhula juncea* Schroet., Pilz. Schles. i. p. 441.

Illustrations: Boudier, Icon. Mycol. i. tab. 176; Harper, loc. cit. tab. 5.

Plants filiform, simple, in groups of two or three, dirty yellow, then tinged rusty, or brownish-drab; smell none; taste distinctly acrid. *Clubs* slender, weak, wavy, not brittle, 8–12·5 cm. high, 0·5–1·5 mm. thick, apex pointed. *Stem* long, up to 2 mm. thick, woolly. *Flesh* uniform. *Internal structure* in transverse section pseudoparenchymatous throughout, with occasional large air-spaces. *Basidia* small, 30–35 × 6–7 (–8)μ, slightly vacuolar; sterigmata 4. *Spores* smooth, hyaline, elliptical and slightly curved, or pip-shaped, with oblique apiculus, 8-11 × 4–5μ.

Habitat. On dead, fallen leaves, etc. Rare. Specimens from Broseley, Salop (W. B. Allen and G. Potts, 1909); Louisburgh (H. C. Hawley, 1910); Mulgrave Woods, Yorks. (Y.N.U. Foray, 1912).

This species is related to *C. fistulosa,* but differs in the very much more slender habit.

SPECIES NOBIS INCOGNITAE.

CLAVARIA MICHELII *Rea,* in Trans. Brit. Myc. Soc. ii. 1902, p. 39.

C. fragilis Holmsk. var. *C. gracilis* Pers., Fr. Hym. Eur. p. 675.

On ground, Dinmore, C. Rea, 1902.

This is a simple yellow species, said to have subglobose spores, $3 \times 2\mu$. It differs in this respect from any of the yellow species with which we are familiar.

C. SUBTILIS (*Pers.*) *Fr.,* Syst. Myc. i. p. 475; Rea in Trans. Brit. Myc. Soc. ii. 1902, p. 39.

Tough, thin, white, becoming yellowish, glabrous at the base, of equal thickness throughout (1 mm.), branches few, dichotomously forked and somewhat fastigiate. Spores white, elliptical, $6 \times 3\mu$. The whole plant is 2–2·5 cm. high.

Amongst grass, Moseley Green, Forest of Dean, C. Rea, 1902. Distinguished from allied species by its small size, equality of thickness, toughness and few branches.

The above is the description given by Rea. Amongst the as yet unidentified material which has come into our hands there is a slender whitish or pale yellow branched species, sent by Miss Lister from Theydon Forest, which would pass very well for this species as regards habit, but the spores are subglobose, 3μ, hence it cannot be regarded as identical.

C. TENERRIMA *Mass. et Crossland,* in Naturalist, 1904, p. 2.

Gregaria subtenax farcta candida; clavis simplicibus cylindricis flexuosis apice subattenuatis; sporis hyalinis subglobosis apiculatis verrucosis, 8–9μ

Sporophores entirely shining white, gregarious but quite distinct at the base, cylindrical, smooth, apex slightly attenuated but by no means acute, base not narrowed, 2·5–4 cm. high, 1·5–2 mm. thick. Basidia bearing four spores.

Said to be characterised by the slender, cylindrical, flexuous sporophore, and more especially by the subglobose spores having the epispore densely covered by minute rounded warts.

Unfortunately the type specimen does not appear to have been kept. The only white species with rough spores seen by the authors has spores with quite distinct, comparatively long spines, and is obviously *C. asterospora* Pat. The suspicion arises that *C. tenerrima* may have been really *C. acuta,* the

spores of which have granular contents, and might have appeared to be rough.

SPECIES EXCLUDENDAE.

C. Ardenia Sow., Col. Fig. tab. 215. = *C. fistulosa.*

C. aurea Fr., Epicr. p. 574. None of the British specimens seen can be satisfactorily distinguished from *C. flava.* The statement by Fries that *C. aurea* differs from *C. flava* in its coloured spores cannot be maintained, since as already pointed out the spores of all in this section are coloured. The further distinction of habitat is of no value, as *C. flava* occurs in both coniferous and frondose woods.

C. canaliculata Fr., Obs. 2, p. 294. = *C. rugosa.*

C. chionea Pers., Myc. Eur. i. p. 167. = *C. Kunzei.*

C. ceranoides Pers., Syn. p. 594. This was founded on Sowerby, tab. 235, which is obviously a form of *C. fusiformis.*

C. coralloides Linn., Flor. Suec., ed. 2, 1755, p. 457. At first applied to various branched species, but the name appears to have been used by Fries and others for large forms of *C. cristata.*

C. condensata Fr., Epicr. p. 575. Indeterminable.

C. crassa Britz., Hymenomycet. aus Südbayern, 1885, p. 286. Has the form and spores of *C. rugosa,* but was said to be tinged violet. Probably = *C. rugosa.*

C. crispula Fr., Syst. Myc. i. p. 470. Indeterminable.

C. crocea Pers., Icon. et Descr. p. 36, tab. 11, fig. 6. Indeterminable.

C. curta Fr., Monogr. ii. p. 281. Indeterminable.

C. dissipabilis Britz., Hymenomycet. aus Südbayern, 1885, p. 289. = *C. inaequalis.*

C. falcata Pers., Comment. p. 81. = *C. acuta*? (See these Trans. iii. p. 32.)

C. filicina Sacc. et Syd., Syll. xiv. p. 238; *C. cervina* W. G. Smith, in Journ. of Bot. 1873, p. 66. Apparently a good species, but doubtless an introduced plant, and therefore not included in this account of British forms.

C. flavipes Pers., Comment. p. 75. Indeterminable. (See these Trans. iii. p. 266.)

C. fragilis Holmsk., Beata ruris, p. 7, tabs. 2 and 3. The right-hand figure of tab. 2 is *C. vermicularis.* The other simple white forms in tab. 2 and the yellow forms in tab. 3 are not identifiable with certainty from the figures alone, and the name should be dropped.

C. grisea Pers., Comment. p. 44. = *C. cinerea.* (See these Trans. iii. 1909, p. 184.)

C. Kewensis Mass., in Journ. Bot. 34, 1896, p. 470. = *C. stricta.*

C. Krombholzii Fr., Epicr. p. 572. The figures of Krombholz on which this species was founded may have been forms of either *C. Kunzei* or *C. rugosa,* possibly both. No species distinct from either that would answer to *C. Krombholzii* has been seen by the authors.

C. pyxidata Pers., Comment. p. 47, tab. 1, fig. 1. Possibly an abnormal form of *C. stricta,* since it occurred on wood.

C. rufa Pers., Comment. p. 71. = *C. inaequalis.* (See these Trans. iii. p. 33.)

C. rufescens Schaeff., Icon. Fung. tab. 288. = *C. botrytis.*

C. spinulosa Pers., Obs. Myc. 2, p. 59, tab. 8, fig. 1. Indeterminable.

C. striata Pers.; Persoon's figure suggests a discoloured *C. vermicularis.*

C. tuberosa Sow., Col. Fig. tab. 199. The figure suggests an abnormal form of *C. fistulosa,* but was referred by Fries and Quélet to the genus *Calocera.* Probably not determinable.

C. uncialis Grev. = *Pistillaria.*

THE OCCURRENCE OF OAK MILDEW ON BEECH IN BRITAIN.

By A. D. Cotton, F.L.S.

The fungus which now so generally occurs on coppiced oak in this country was first noticed in Europe in 1907 and was probably introduced from America. Its spread in Europe was remarkably rapid and by 1909 it was known from almost every European country and had moreover spread through Turkey into Asia Minor.

The fungus for a time remained unnamed since, owing to the absence of perithecia, it was impossible to determine its generic position. In 1910 Griffon and Maublanc named the conidial stage *Oidium alphitoides,* and the following year Arnaud and Foëx recorded the occurrence of occasional perithecia production from which it was apparent that the fungus was a *Microsphaera,* and was regarded by them as a form of *M. Alni.* This view has in the main received acceptance and is endorsed

by Mr. E. S. Salmon, the author of the monograph of the Erysiphaceae. Some difference of opinion, however, exists as to whether the fungus should be regarded as species, variety, or biologic form, and a number of papers bearing on this subject, especially in French journals, have been published. Griffon and Maublanc regard it as a distinct species and have published the name *Microsphaera alphitoides*.

The method of over-wintering of the Oak Mildew fungus is the same as that which occurs in the fungi causing Apple Mildew and Hawthorn Mildew, namely by the hibernation of mycelium. The latter penetrates the buds in autumn, remains dormant during winter, and develops again in spring with the unfolding of the leaves. It would seem that only a very few buds are infected in this way but it is obvious that a sufficient number occur to provide a copious supply of conidiospores and general infection each season. The production of perithecia is therefore not required.

A considerable amount of work on the biology of the fungus has been carried out on the Continent and one of the fullest accounts of such work is that by Neger (Naturwiss. Zeitschrift. für Land- und Forstwirtschaft. xiii). With regard to its occurrence on Beech, several workers have recorded this phenomenon, e.g. Griffon and Maublanc 1908, Ferraris 1909, Forneti 1910, Müller 1911, Hauck and Kölpin Ravn 1913, and Neger 1915, but apparently the last-named alone clinched the matter by means of artificial cultures. The occurrence of the mildew on Beech is therefore not new but a record of its occasional appearance in this country is none the less of interest.

The mildew was observed on this host by the writer near Sevenoaks, Kent, on several occasions in July 1918. It occurred on shoots springing from the stumps of old trees which had been cut down and in some instances it was quite clear that the Beech was being infected directly from spores produced on the Oak. In one case some half-dozen stumps in the immediate neighbourhood of badly mildewed oak shoots possessed young shoots most of which were more or less mildewed, whilst the shoots of other stumps not in close proximity to mildewed oak were clean. Closer inspection showed that young beech shoots growing immediately under infected oak were developing a slight growth of mildew, whereas the other shoots of the same age not beneath the oak shoots were free from attack. The affected shoots were so close to the oak that a copious supply of spores must have fallen upon them, and the young leaves must have received a constant new supply of spores during the whole period of their development. When infected directly from

the oak it would appear that only very young leaves are susceptible, but it is possible that conidia produced by the beech might give a higher percentage of successful infections. It should perhaps be added that these observations were confirmed by microscopic examination, and that at the time Neger's experiments were unknown to the writer.

One of the most interesting features connected with the above phenomenon is its comparative infrequency. The occurrence of Oak Mildew on Beech was recorded ten years ago by Griffon and Maublanc, yet the Beech remains as generally immune from attack to-day as it did then. On the Oak the mildew is found specially on closely cut hedges, coppiced plants, and on the young summer growth on the lower parts of trees. Although the Beech is not coppiced and makes little secondary growth, closely trimmed Beech hedges are general throughout the country but in no case have these been observed attacked by the mildew.

ENTOMOGENOUS FUNGI NEW TO BRITAIN.

By A. D. Cotton, F.L.S.

Very few observations have been made in this country on entomogenous fungi and the occurrence of any species not hitherto recorded is worthy of a special note. Of the following species the three on Aphides were discovered by Miss D. J. Jackson in the course of research carried on by her on the distribution of these insects in Scotland. They were forwarded to the Pathological Laboratory at Kew for determination and I am indebted to her for permission to publish the records. The fourth species *Empusa sphaerosperma* was collected by Mr. W. Watson and determined by Miss E. M. Wakefield. The three species of Empusae appear to be new records for Britain, but it is probable that they are not uncommon.

Since the descriptions of these three fungi are not readily accessible to all workers, the diagnoses as given in Thaxter's excellent monograph "The Entomophthoreae of the United States" are added to each.

EMPUSA (ENTOMOPHTHORA) APHIDIS Hoffman, in Fresenius, Ueber die Pilzgattung Entomophthora, p. 84; Thaxter, Entomoph. United States, pp. 175–177, Pl. 18, figs. 220–240; Jackson, Notes on the Aphides of Ross-shire, p. 82.

Conidia ovoid to elliptical or subfusiform; commonly asymmetrical and very variable, with papillate base and containing numerous oil globules. Average measurements 25 × 12μ, maximum 16 × 40μ. *Conidiophores* digitate, often simple. Hyphal bodies spherical, germinating in all directions and giving rise to numerous contorted hyphae which grow into conidiophores. *Cystidia* rather slender and tapering at their extremities. *Secondary conidia* like the primary, or short ovoid with a single large oil globule. *Resting spores* "spherical, 33–45μ in diameter and borne terminally or laterally on hyphae" (Fresenius and Sorokin). Host attached to substratum by rhizoids, few in number, and usually terminating in a disc-like expansion.

Habitat. In *Macrosiphum lactucae* Schrank., on gooseberry, Swordale, Evanton, Ross-shire, September 18, 1917; in *Macrosiphum allii* Jackson, on *Allium Porrum*, Swordale, Aug. 12, 1918; in *Rhopalosiphum lactucae* Kalt., on gooseberry, Swordale, Aug. 12, 1918. Coll. D. J. Jackson, Sept. 1917, and Aug. 1918.

In alluding to this species Miss Jackson makes the following notes in her paper referred to above: The species is very common and many Aphides are killed by it. Individuals in which the fungus is present are easily distinguished by the dull ochreous colour and opaque appearance, which is quite different from the shining look of healthy specimens. They possess also a rough appearance due to the skin being distended all over into numbers of small elevations, each elevation being caused by a spherical spore-cluster (of which the body is entirely made up) pushing the skin outwards. Aphides killed by this fungus remained adhering to the under side of the gooseberry leaves.

EMPUSA (TRIPLOSPORIUM) FRESENII, Nowakowski, Entomoph. p. 171, Pl. xii. figs. 115–125; Thaxter, Entomoph. United States, pp. 167–169, Pl. 16, figs. 106–140.

Conidia nearly spherical to short-ovoid, often with a short, truncate or commonly slightly papillate base; with granular contents; without large fat globules, and slightly smoky in colour; 15 × 18—18 × 20μ. *Conidiophores* simple, arising directly from small, spherical hyphal bodies of a yellowish colour. *Cystidia* not observed. *Secondary conidia* of two

kinds: the first like the primary, the second almond-shaped and borne obliquely on capillary conidiophores. *Resting spores*, zygospores, elliptical or subovoid, yellowish, becoming often smoky and opaque, formed by the conjugation of two small, spherical hyphal bodies by means of slender gametes, above the point of junction of which the spore rises as a bud; average measurements 30 × 19μ. Host attached to substratum by the insertion of its proboscis.

Habitat. In *Rhopalosiphum lactucae* Kalt. and *Myzus Whitei* Theobald, on gooseberry, Swordale, Evanton, August 1918; *R. persicae* on potato, Stirkoke, Wick, Sept. 9, 1918. Coll. D. J. Jackson, Aug. 1918. Apparently not uncommon in eastern states of America, being recorded from several localities by Thaxter.

"Several apterous viviparous females of *R. persicae* found adhering to the underside of potato leaves were covered with this fungus. Other specimens developed the fungus when in captivity. The fungus was ochreous white on some specimens and pale pinkish in others." D. J. J.

EMPUSA (ENTOMOPHTHORA) SPHAEROSPERMA, Fresenius, Notiz, p. 883; Thaxter, Entomoph. United States, pp. 172–175, Pl. 17, figs. 200–219.

Conidia long-elliptical to nearly cylindrical, papillate at base and tapering very slightly near the rounded apex; 15–26 × 5–8μ, average 20 × 5·5μ; usually with a fine granular contents and a central oval nuclear body. *Conidiophores* digitate, much branched and confluent over the body of the host, forming usually a mass the upper surface of which is flattened. Colour of the fungus as a whole white, varying to bright pea green. *Cystidia* slender, tapering, not abundant. *Secondary conidia* like the primary, or long almond-shaped and borne on a capillary conidiophore. *Resting spores*, azygospores or zygospores (?), borne laterally or terminally from hyphae, 20–35μ, average 25μ, spherical, hyaline or very slightly yellowish. Host attached to substratum by rhizoids.

Habitat. In a small green caterpillar on grass. Rushton, Somerset. Coll. W. Watson, May 1918.

A widely distributed and common species and one remarkable for the great diversity of its hosts, being known to occur on Lepidoptera, Hymenoptera, Diptera, Coleoptera, Hemiptera, Neuroptera, Thripidae. Thaxter notes that it produces epidemics of considerable proportions and mentions clover weevils and certain small flies being killed in large numbers. In a third case a severe epidemic occurred on the leafhoppers of roses and apples

(*Typhlocyba rosae* and *T. mali*); and in an apple orchard in Maine tens of thousands of leafhoppers were killed, a dozen or more being often found fastened to a single leaf.

Cladosporium aphidis Thüm., in Oesterr. Bot. Ztschr. xxvii. p. 12 (1877).

Habitat. On dead body of a late viviparous female of *Macrosiphum dirhodum* Walker, on rose leaf, Balconie, Evanton, Ross-shire. Coll. D. J. Jackson, Oct. 1917.

Though usually listed as a distinct species it is probable that this fungus is merely a form of *C. herbarum*. Miss Jackson remarks that the fungus was found on a dead specimen and there was no evidence as to whether the aphide had been killed by Cladosporium or not.

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SOME CONCEPTS IN MYCOLOGY—AN ATTEMPT AT SYNTHESIS.

By William B. Brierley.

In every branch of Science there are a number of observations and ideas, which, sometimes in their original form, sometimes modified or augmented, are handed on from one generation of students to the next, from one writer of text-books to another writer of text-books. In course of time many of these fade into oblivion, but others are retained and become an integral part of the Science. One learns them of one's early teachers, imbibing them almost unquestioningly, and they form part of one's ideational system.

An example—not the best that could be given, but one personally interesting—may perhaps serve to make this more evident. Every student knows that growth in dicotyledons takes place in the cambial layer. The nuclei of cambial cells ought therefore to be in a constant state of division, and yet how many botanists have ever seen a mitotic figure in a cambial cell? For some time, when opportunity has permitted, an inquiry has been made, and up to the present not one of many well-known workers has answered in the affirmative. Granted that it is in the highest degree probable that dicotyledonary growth does take place in a cambial layer, and that the nuclei of these cells do shew mitotic figures: that the concept of cambial dicotyledonary growth is a true one: nevertheless it surely would be advantageous that such a fundamental process should be more frequently observed, and that the published figures should be more numerous and representative of modern cytological technique.

There is no reason to doubt that many concepts in biological science correspond to reality; but one may perhaps be forgiven for wondering occasionally how many others gain continued allegiance mainly by sheer conservatism and inertia. It could only serve a useful purpose if, periodically, certain of these concepts were revised in the light of more recent knowledge, were weighed in the balance, and if found wanting, neither

high authority nor ancient status and respectability were allowed to preserve them save as interesting historical relics.

In this note I wish to draw attention to certain concepts, of importance in mycology and possessing many wider applications, which would perhaps appear to merit some reconsideration in the light of present knowledge. If the result of such consideration be confirmatory, mycologists will hold and elaborate their theses with the greater surety and profit. If the outcome be to throw doubt upon accepted beliefs, that also is good, for we shall no longer bow down before false idols.

I. *The Species Concept.*

When a number of specimens are examined and the statement is made that this organism is *Ustilago Cardui*, and that organism *Ustilago violacea*, and so on, what is the connotation of these terms? At first sight, perhaps, such a question may seem pedantic and of mere academic interest; but these and other fungi are disease-producing organisms and the problem of their specific identity and recognisability is one most vital to any clear formulation and indeed essential to any true progress in mycology.

Certain morphological characters *A*, *B*, *C*, *D* are noted in a particular fungus and to it the name $\alpha\beta$ is given. Another fungus possesses the characters *A*, *B*, *C*, *E*, and receives the name $\alpha\gamma$. A third presents characters *A*, *B*, *C*, *L*, and is named $\alpha\delta$. The generic characters *A*, *B*, *C* these fungi all possess, but they differ from each other in the one or more minor characters *D*, *E*, *L*, and these serve to differentiate them as species. If the morphological difference be, however, very striking, the fungus may be given the status of a new genus, whilst if inconspicuous the fungus may be graded as a variety of some other already known species. For example, the genus *Phomopsis* has certain morphological characters and *P. hysteriola*, differing from *P. striaeformis* in certain minor ways, is graded as a variety of the latter. If now a single specimen were found with all the characters of *P. hysteriola*, save only that it possessed large dumb-bell shaped spores, this striking difference would certainly be sufficient to raise the specimen to the rank of a new genus. And so a "Sylloge Fungorum" has been evolved, the criteria of all the several ranks being confessedly arbitrary.

This creation of new fungal species and their subsequent determination from descriptive diagnoses is based on certain assumptions which may perhaps be briefly expressed as follows:

(1) The characters separating one species from another are of morphological nature.

(2) The essential specific characters are constant and hereditary ("nulla certior. . . quam distincta propagatio ex semine").

(3) The essential specific characters of an organism may be determined and evaluated by sight in one specimen of one generation.

Now these assumptions, and all that gigantic and rather wonderful superstructure of fact and fancy which is erected upon them and which we call systematic mycology, take origin in a philosophic concept, that of the *species*. The essential quality of a species is that the different individuals included in it be identical, and throughout all systematic mycology morphological comparison is accepted as a criterion for specific purity. The species concept therefore may perhaps be expressed as follows—a species consists of the total of individuals possessing essentially similar morphological facies. The species is thus a morphological abstraction.

Such a species concept is not of course confined to mycology but is common to and is held with varying degrees of rigidity in all branches of systematic biology.

So far as the flowering plants are concerned, however, it has long been recognised that the morphological facies of an organism may vary according to development under different environmental conditions. For example *Leontopodium alpinum* growing on a mountain summit is hardly recognisable as the same species as this plant growing in a lowland meadow. *Polygonum amphibium* has a terrestrial variant extremely different from the aquatic or the xerophytic growth form; and so also *Ranunculus sceleratus* and many other plants. These organisms are plastic and the particular morphological facies of a specimen is clearly a resultant of two systems of interacting forces represented by the living substance of the organism and the conditions of life*. In the phanerogams, however, it is but rarely that these ecologic growth forms or "ecads," to use the name given to them by Clements(6), differ markedly in the essential morphological characters of their reproductive members, and consequently the underlying specific identity may usually be traced with ease throughout.

* As Baur says (Einführung in die Exakte Vererbungslehre Auf. 2, 1914) "Only a certain specific type of reaction to the external world is inherited, and what we perceive with our senses as external characteristics are only the result of this reaction on a chance combination of external conditions under which the individual has developed." And MacLeod (24, 2), "The so-called characteristics of each species are the product of reactions, in which there intervene on the one hand the external causes which affect the individuals during their development, and on the other hand the living substance of the species under consideration."

But even when plasticity has been recognised, the problem of systematic categorisation is not by any means rendered simple for there is still the question of specific variability. The variability of many phanerogamic species has been shewn to be due to the fact that the species group really consists of two or more elementary or Jordanian species as in the well-known cases of *Draba verna*, *Capsella bursa-pastoris*, *Solanum nigrum*, etc. Each of these little species may itself be plastic. Furthermore it is very probable that many elementary species may consist of two or more of Johannsen's(19) *pure lines* separated from each other by qualitative chemical differences, each pure line being itself plastic*. Moreover not only may external causes bring about the production of different morphological facies in specimens of the same species, but inversely the essential differences of two or more elementary species may themselves disappear under the influence of certain environmental conditions. For example, the pink colour of the corolla of certain elementary species of *Primula sinensis* may be eliminated by growing the plants at a higher temperature, and the resulting white forms may then no longer be distinguished from elementary species characterised by the possession of white corollas. The same phenomena may be brought about with the blue corolla of certain Campanulas, or the red colour of the copper beech which may be eliminated by development in deep shade. And complicating all these things is the gametic condition of the organism and the discovery of Nilsson-Ehle(31) that a pure line may be homozygous in respect to one character and heterozygous in respect to another.

In the phanerogams the different species are distinguished by many characters; units each of which may be investigated separately. And yet even this very brief indication of some of the difficulties involved in the systematic treatment of such plants will serve to shew that the prevailing morphological species-concept depending upon the "systematische blick" is far from being finally satisfactory.

When, however, we attempt to apply this concept to the already known facts of mycology and to the everyday laboratory and field experience of the experimentalist we create a total impasse.

An adequate review of the literature cognate to this subject is not feasible here. As however the most critical descriptive character in the systematic treatment of fungi is the reproductive body, attention may be drawn to a few of the more recent

* "Each animal and vegetable species differs strictly from all others by the chemical composition of its living substance." (MacLeod 24, 2.)

investigations dealing with variations in the size, shape and colouring matter of the spore.

That the essential morphological characters of fungal spores are not necessarily constant under different conditions has been shewn by Stevens and Hall(44) for species of the genera Septoria, Ascochyta, Volutella, Spermoedia, Coniothyrium, Epicoccus, Colletotrichum, Phyllosticta, Alternaria, Sclerotinia and Diplodia; by Mutto and Pollacci(29) for species of Coniothyrium and Phyllosticta; by Stakman(41, 1) for *Puccinia graminis*; by Long(22a) for *Puccinia ellisiana* and *Puccinia Andropogonis*; by Moreau(28) for *Sporodinia grandis*; by Elliott(11) for Macrosporium and Alternaria; by Gaümann(14) for Peronospora; by Beach(3) for Septoria and by numerous investigators for species of many other genera of fungi.

There is thus a considerable body of evidence to shew that the essential descriptive characters of fungal spores may largely be determined by the conditions under which the fungus develops, and that environmental changes may result in modification of spore characters. Nor is it only the morphological features of the spores which are altered: the whole structure and facies of the organism may undergo transformation.

In bacterial studies such artificially induced modifications of the organism constitute a major part of the common laboratory technique, and are utilised extensively and often exclusively in specific determinations.

In mycological studies, however, although cultural modifications are the daily experience of laboratory workers, they are still practically unrecognised by the systematist, and when recognised either neglected or regarded as abnormal or bizarre phenomena "idle to speculate upon." Innumerable instances of such morphological transformations are scattered through the literature of three decades, or could be given out of one's own experience.

Thus after a very thorough and intensive cultural study of certain species of the genus Penicillium, Thom(45) remarks "In experimental cultures changes in the chemical nature of the medium or in the conditions, or both, have been found to produce great changes in the morphology of the fungi studied. With the exception of a few fundamental group or generic characters nearly every attribute used in specific description has been shewn to be a reaction to environment, hence changeable with such environment (for some species at least)." And again, "Many species differ so materially in gross characters when grown upon these different media that successive cultures, if not known to be pure transfers, might be supposed to be

different species; but when returned to the original media and conditions these forms have immediately produced the characters and reactions first found, with a large degree of uniformity."

Fifteen years ago Smith and Swingle(40) wrote of their *Fusarium oxysporum*, "...This fungus shewed a number of very striking variations. For this reason it is impossible to give a general description that will hold universally." After quoting descriptions of eleven old species of Fusarium from potatoes, the authors conclude as follows: "Judged by the above descriptions, we have had a half dozen or more species of Fusarium in our culture tubes, some of them 'new species,' and yet all were the product of a single spore. This does not mean that there have been in our cultures any very wonderful transmutations of one thing into another, but only that organisms respond to their environment, and that 'species descriptions' of the kind cited have not taken this fact into consideration, and consequently are worthless for scientific purposes. This is not a new idea, but it is a fact to which the attention of systematic mycologists might be directed profitably at frequent intervals."

A few years later Stevens and Hall(44) drew attention to this same fact and wrote "If a fungus can be easily changed as regards its essential descriptive characters by a change in substratum, density of infection or other environmental factor, these characters are worthless for descriptive purposes unless the conditions under which they develop be accurately known."

And yet mycological journals are still largely filled with these "worthless descriptions," and instead of the collecting of facts and material, mycological nomenclature is increasingly encumbered with more and more names.

From what has already been said it must surely be granted that the morphological facies of an organism is not necessarily a constant expression, but that it may vary *beyond the recognised limits of the species* under the influence of changed environmental conditions. Is such variation sporadic and irregular or does it exhibit a constant and definite relation to particular cultural factors and stimuli? In bacterial investigations of a decade and more ago this question was all important and still unanswered; but with fuller knowledge and more particularly with the ever-increasing refinement of technique it has been demonstrated that the response of bacteria to standardised factors is definite and constant.

The technique of mycology is still far from perfect for the science is but young, and we cannot as yet answer the question with an unconditional affirmation. With the exception, however, of some few doubtful results such as those of Shear

and Wood(38) on the genus Glomerella, evidence is rapidly accumulating to shew that under recurrent identical conditions the morphological variation of a particular fungus is definite and constant.

Many detailed examples could be given but perhaps two or three from one's own experience may suffice.

If *Fusarium arcuosporum* and *Fusarium angustum* be grown on Czapek's medium with five per cent. glucose, the former is pink and the latter is colourless. If, however, the same medium contain thirty per cent. of glucose, the former is clay-coloured whilst the latter assumes a bright-purplish vinaceous hue. In a neutral Czapek medium *Fusarium sclerotioides* possesses a greyish-white aerial mycelium, but in a like medium plus 0·4 per cent. by weight of citric acid the aerial mycelium is pink-vinaceous. These and many similar colour reactions may be obtained with the most perfect constancy. Again in certain fungi which have been investigated the expectation of identity of reaction under constant conditions is fulfilled with mathematical accuracy. Thus a certain pedigree pure line strain of *Botrytis cinerea* growing under rigidly standardised conditions on the media—steamed sugar-beet root, fresh onion bulb scales and potato agar has the following respective values of its mode spore: $9{\cdot}3\mu \times 6{\cdot}6\mu$; $9{\cdot}3\mu \times 6\mu$; and $9{\cdot}3\mu \times 4{\cdot}6\mu$. These are extremely slight differences, but they are mathematic constants.

All the more recent and accurate work indicates that the fungi like the bacteria respond to particular environmental conditions in definite and characteristic ways; and the present position of this question may fairly be summarised by the following quotation from Thom(45). "The question at issue was not whether or how variations could be produced, but whether a particular variation is constantly produced by a species in a particular environment." "In those species most thoroughly studied both the physiological and morphological reactions have appeared to be very reliable."

A further development of the fact of plasticity and constancy of response to definite environmental conditions, is the phenomenon of morphological *convergence* or *divergence* of two or more organisms under the influence of external factors. This may perhaps most clearly be illustrated by the diagram on p. 211.

The numbers 1, 2, 3, 4 represent distinct organisms growing under the influence of environmental conditions represented by the capital letters *A, B, C, D, E*. The small letters shew the growth forms or morphological variations of the organisms under the differing conditions. Thus organism 2 under external factors *C* exhibits the morphological facies represented by "*n*."

Now it may happen that organisms 1 and 2 under the influence of like conditions (*A*) will produce growth forms having similar essential descriptive characters. Under environmental factors represented by *B*, *C* and *D*, however, the morphological characters of the growth forms may be very divergent. On the other hand organisms 2 and 3 may converge under the influence of *D* and the former may also exhibit a similar "ecad" when stimulated by *C*. Thus 1*A* and 2*A* would on the basis of morphological comparison be regarded as a single species, as would also 2*C*, 2*D*, and 3*D*. The constitutional distinctness of the three organisms would however be clearly visible were

	A	*B*	*C*	*D*	*E*
1	*k*	*a*	*l*	*a*	
2	*k*	*m*	*n*	*n*	
3	*f*	*d*	*y*	*n*	
4					

the morphological response to two or more environmental systems observed. As Thom(45) states, "Two species closely similar when grown parallel in one environment may differ characteristically when transferred to a different medium or a different set of conditions."

Before continuing further the discussion of plasticity attention may briefly be drawn to a factor very seriously complicating all systematic treatment of fungi, in which the criterion of specific purity is morphological comparison. This is the undoubted fact that very many accepted fungal species are aggregates of two or more elementary species each of which is plastic, the ecads or growth forms converging or diverging in constant and definite relation to the adjustment of the physico-chemical factors of the environment.

Furthermore as stated by Dox(9), "While various species of these two genera may be closely related morphologically, they often shew wide chemical differences." To such chemical species perhaps belong the so-called "biologic races" of *Puccinia graminis*, Erysiphe, Monilia, etc.

The foregoing facts may be the more explicit if expressed briefly in concrete terms. Let us take, by way of illustration,

a tomato fruit which has been attacked by *Botrytis cinerea* and of which a large portion of the surface is covered by the smoke-grey conidiophores of the fungus. The following possibilities are present:

(i) The growth may consist of a single "chemical species."

(ii) The growth may consist of two or more "chemical species" growing mixed together. These would present no morphological distinctions but would be separable on culture media by their chemical reactions.

(iii) The growth may consist of a single elementary species.

(iv) The growth may consist of two or more elementary species.

(*a*) The species may be such as diverge on the medium. An examination of the morphological characters of the growth would shew considerable variations and the curves might be multimodal or the separate curves might associate to form one regular variation curve. With suitable cultural and mechanical technique the different elementary species could be isolated. Such a growth would correspond to a mixture, for example of "*a*" and "*m*," representing organisms 1 and 2 developing under environment *B*.

(*b*) The species may be such as converge on the medium. The morphological variation would be comparatively small and the curves would be unimodal. By transplanting the growth to a series of media the components would diverge and could then be isolated. Such a growth would correspond to a mixture of for example "*k*" and "*k*," representing organisms 1 and 2 developing under environment *A*.

Accepting morphological comparison as a criterion of specific purity, the growth would, in all the above cases, have been regarded as a single species.

Finally there is the case not illustrated in the foregoing summary where the same morphological facies is presented by two different elementary species growing under different conditions—for example, "*n*" and "*n*" representing organism 2 under conditions *C*, and 3 under conditions *D*.

It does not necessarily follow therefore that two fungal organisms presenting identical morphological characters and growing under either like or unlike conditions necessarily belong to the same fungal "species"—that a Stysanus growing upon a potato tuber is necessarily the same "species" as a morphologically identical Stysanus also growing upon the tuber or upon a decaying tree stump.

This being so it must be obvious that the morphological species concept—the total of individuals possessing essentially similar morphological facies—is a false concept; and not only

so, but that even as a temporary working hypothesis it is valueless and only increases the existing confusion in mycology. The utmost that may be achieved by the practical application of such a concept, and this is the systematic mycology of to-day, is the minute description of ecologic variants and growth forms, the "ecads" of Clements(6). The true species implying identity of constitution has no existence in such a concept.

It would be a profitable and fascinating study to examine in some considerable detail the philosophic bases for a species concept, beginning from the known facts of mycology, but the most that is feasible here is merely to indicate certain of the main directions in which such a consideration would perhaps progress.

At the present time we have no knowledge of living organisms apart from some particular environment, such environment varying from a stump in a tropical forest to a standardised synthetic medium in a laboratory. The visible organism is a morphological entity which may as we have said shew a different morphological facies under other environmental conditions. Each individual is therefore a growth form or "ecad," and every ecad may be regarded as being the morphological expression of the resultant of two interacting series of forces. One of these force systems is the living matter or the organic individual which itself is an almost infinite complex of metabolic reactions in a colloid substratum. The other force system is the infinite complex of physico-chemical reactions which constitutes any particular environment. Thus the morphological expression of the resultant of the interaction of two force systems represented by a certain organic individual and an aqueous environment, is that growth form which we term the aquatic variant of *Ranunculus aquatilis*. The same force system which is the organic individual, interacting with a second force system which is certain conditions of development on land, gives a resultant the morphological expression of which is the terrestrial variant of *Ranunculus aquatilis*. One may draw illustrations from chemical phenomena and the analogies may have far greater significance than merely an illustrative value. The force system copper, interacting with the force system nitric acid, produces a resultant having the facies of copper nitrate, but the resultant of the interaction of copper with a different environment, sulphuric acid, is expressed by the substance copper sulphate. From the phenomena of crystallisation one could adduce much more exact analogies.

But the existing organic entity is far greater than the morphological structure which is its visible expression. Much more

truly the organism is to be regarded as the physiological equilibration, the complex of reactions in the colloid substratum; while the colloid substratum and the morphological structure of the organism represent the "residue" from the metabolic processes, the excess of intake over outgo. Nearly seventy years ago Huxley(18) wrote of the cells, the structural components: "They are no more the producers of the vital phenomena than the shells scattered along the sea beach are the instruments by which the gravitative force of the moon acts upon the ocean. Like these the cells mark only where the vital tides have been and how they have acted." It will be evident that any chemical substance which can be completely utilised by the metabolic processes will not appear as a visible part of the body of the organism. The body, the structure and morphology of the organism, is a by-product of the metabolic reactions. As such by-product can only escape from the cell by decomposition, it constitutes therefore the more permanent matter of the cell and appears as a visible substratum. It may be regarded as residue left behind by the metabolic tides, shewing how they have acted.

Under identical conditions the structural substratum of different organisms differs because the physiological constitution of the living matter of the organic individuals differs. Thus the morphological distinctions between two species are produced; but these divergent morphological facies are merely the expressions of the differing physiological constitutions, and have no permanent value or even existence apart from the particular environmental conditions under whose influence they are created. Under varying conditions the same physiological constitution will give rise to different morphological expressions and so one finds growth forms or "ecads." Under recurrent identical conditions the same resultant will be produced by the same physiological constitution giving constancy of reaction in like environments.

But just as, for example, a resultant of sixteen may be the expression of various interacting factors such as four and four or eight and two or sixteen and one, so, differing physiological constitutions may under the influence of certain different external stimuli produce the same resultant or "ecad." Moreover the force system representing the environment is infinitely complex and it may often happen that two or more different physiological constitutions may react with different smaller force systems within the same environmental complex, so that similar resultants ensue. Thus two distinct species may under apparently identical conditions give rise to "ecads" morphologically indistinguishable from each other.

The primary conception to which all these indications lead is that of an organism as a physiological equilibration functioning about a constant point, and of the environment as a complex of forces with infinite capacity for adjustment. The resultant of the interaction of the metabolic entity and the environment is the growth form or "ecad." The constant or specific function is the metabolic entity or physiological constitution and not the morphological individual which is merely the visible expression of the reactions of the physiological constitution under particular conditions.

It follows therefore that the *morphological* species concept—the total of individuals possessing *essentially similar morphological facies*—must be abrogated and in lieu thereof be substituted the *physiological* species concept—the total of individuals possessing *essentially similar physiological constitutions.*

The morphological concept regards the species as an entity in *space*: the physiological concept regards it as an entity in *space* and in *time.* In other words the species is a dynamic relation and not a static figure; it is an event and not a thing.

Before concluding this brief consideration of the species concept attention may be drawn to certain minor issues which arise directly from it. Once having substituted the physiological concept for the morphological one, and having accepted the implications which such a viewpoint involves, it is recognised that the systematic categorisation of fungi must coincide with and take fully into account the known facts of their *behaviour.* It is clear that many, perhaps most of the Linnean species of fungi have no constant existence in fact; they are merely aggregates of growth forms or "ecads." Many of them are aggregates of elementary species, themselves plastic; many elementary species are aggregates of physiological or chemical species, producing constant variations under recurrent conditions.

The only exact method of species creation and specific determination is by means of quantitative data derived from cultural treatment under standardised physico-chemical conditions, for this method alone reveals the physiological constitution of the organism. To-day, merely to describe the essential morphological characters of a particular growth form of a fungus, and so create a new species—*if that organism can be grown in pure culture*—exhibits not only a complete ignorance of the philosophy of mycology, but a total inaptitude to appreciate the developments of the subject and to apply to it the elementary principles of scientific methodology.

Certain fungi, however, cannot yet be grown *in tubus*, but here surely the imperative need is not increase in the already bewildering accumulation of binomial terms applicable largely

to evanescent morphological facies, but the concentration of energy in the discovery of suitable breeding technique. The results obtained in the cultural treatment of organisms pathogenic to man must here be an inspiration.

Attention is most usually drawn to the Hymenomycetes and the application of a physiological concept of species in their systematic treatment derided; the opinion being expressed that although the lower fungi may be plastic, such groups as the Agaricineae, Polyporeae, etc. contain species well defined and constant, whose specific purity may be determined by morphological comparison alone. It is extremely improbable that this is true. In the Agaricineae are a very great number of growth forms which have been studied so minutely and patiently and their essential descriptive characters placed on record so fully, that few possible permutations or combinations of morphological characters can remain unreported. This huge assemblage of forms has been arranged by certain artificial criteria so that whenever a growth form is examined it may be relegated to one or other of the almost innumerable diagnoses in existence. These diagnoses are regarded as distinctive of species but their true value is that of "ecad" descriptions. If reference be made to the diagram, the diagnoses do not apply to the species 1, 2, 3, 4 and so on, but to the growth forms *k*, *m*, *l*, *a*, etc. Any one of the species 1, 2, 3 under certain conditions will produce growth forms fitting a particular diagnosis. If, however, species 2 under environmental conditions *E* gives rise to a growth form which has not already been described, a new diagnosis is drawn up fitting the new "species."

If, however, the particular growth form is the morphological expression of the resultant of the interaction of the physiological constitution of the organic individual, and the special environmental conditions, and it is extremely difficult with the evidence at our disposal to conceive what else it can be, then it follows that under certain conditions, like resultants may be produced by unlike physiological constitutions. Thus even in the higher fungi there is no reason to suppose that under the influence of the infinitely variable environmental conditions the phenomena of morphological convergence and divergence are not operative. In such case it does not necessarily follow that two similar morphological entities which may receive the name *Hydnum repandum* or *Agaricus melleus* might not possess totally different physiological constitutions which under other conditions of growth would diverge characteristically. While therefore it is interesting to possess the detailed knowledge which has been accumulated regarding the growth forms of the higher fungi, it must always be realised that the so-called

"species" here are merely "ecads," and in no wise comparable with species of Penicillia as described by Thom(45) or species of Fusaria as diagnosed by Appel and Wollenweber(1) or more recently by Sherbakoff(39). The "species" of Agaricus like the "species" of most other genera of fungi correspond to the morphological variants or "ecads" obtained by the experimentalist when a particular pure line organism is cultivated under different environmental conditions.

It would be advantageous if there could be introduced into systematic mycology some such terminology as that proposed by Lotsy(23) for the phanerogams. Perhaps the main features of this as they apply to fungi may briefly be noted here.

The term *Linneon* is suggested to replace the term species in the Linnean sense, and to designate a group of individuals which resemble one another morphologically more than they do any other individuals. To establish a Linneon consequently requires careful morphological comparison only.

The name *Jordanon* to replace the term species in the Jordanian sense, viz., microspecies, elementary species, subspecies, etc., and to designate a group of individuals externally alike which all propagate their kind faithfully as far as these external characters are concerned, with the only exception of non-inheritable modifications of these characters, caused by the influence of the surroundings in the widest sense, to which these individuals or those composing the progeny may be exposed. To establish a Jordanon, morphological comparison alone does not suffice; the transmittability of the characters by which the form was distinguished must be proved by experimental breeding.

The name *Species* to designate a group of individuals of identical constitution. To establish a species neither morphological comparison alone, nor comparison of the morphological facies of the organisms on standardised series of culture media is sufficient. Analysis of physiological reaction to standardised conditions is required in addition.

The term *Modification* to designate the non-transmittable effect of external circumstances.

The continuance of the present system, or lack of system, in mycological terminology can only add to the existing confusion, and make still deeper and more unbridgeable that ever-widening gulf between the work of the systematist and that of the laboratory and field experimentalist. The adoption of the terminology suggested by Lotsy, which involves the acceptance of the physiological species concept, would not only co-ordinate the systematic treatment of fungi with that of the other great groups in the vegetable kingdom—and surely there is not a

philosophy of mycology different in nature from a philosophy of phanerogams—but it would prove the means of evaluating the herbarium in terms of the laboratory and field, the rigid formalities of an artificial system in terms of the living organism.

Finally attention may be drawn to the fact that the substitution of the physiological in lieu of the morphological species concept implies not only a complete re-orientation of mental attitude, but the unqualified acceptance and unceasing application of a new technique; the quantitative method in place of the qualitative method. One's opinion of the latter may perhaps be better expressed by the following quotation from the recent most suggestive and valuable book of MacLeod(24), "The systematists, confined in an antiquated routine, are the first victims of their deplorable method. Since the great majority of the existing specific and even generic descriptions are superficial and unfinished to such a degree that the exact identification of a specimen is simply impossible, the systematists *discover* continually and describe under new names so-called *new* species, which have already been described either once or even several times." "Moreover, the existing descriptions are ordinarily very incomplete. Only a few characters are mentioned, according to a sort of conventional scheme, which would possibly have been sufficient (or thereabout) a century ago, when the number of known species was comparatively small, but which does not answer the needs of modern science." "The almost incredible imperfection of many well-known works on *fungi* and the deplorable disorder which prevails in this department of descriptive botany," has been illustrated in a very entertaining manner by Lloyd(21) in his "Myths of Mycology."

"The aim of the quantitative method in descriptive science is not only to describe exactly the properties of the species and to make an inventory of the forms of life. *This is important enough in itself,* but there is more. It is difficult to obtain exact data about the development and the anatomy of animals and plants as long as the observed facts are described by means of mere terms. It is still more difficult to discover the origin of species and their phyletic relations without an exact knowledge of the investigated species. This can only be obtained by comparing their characteristic figures with the figures of other species. The object of the quantitative method is, in general, the exact description of the living objects."

Recent workers such as Thom(45), Sherbakoff(39) and others have to a certain extent adopted the quantitative method, but have refrained from doing so entirely, attempting to combine a quantitative with a qualitative technique.

Weidemann(49) and a few more recent investigators have gone further and followed the bacteriologists in giving formulae for a considerable number of media and detailed notes as to reactions upon such media.

In bacterial studies any particular organism may be represented by a number which defines exactly its physiological constitution. If the species concept as described by Lotsy, which is the physiological interpretation put forward in this paper, be accepted, one may anticipate the elaboration of some similar numerical system for recording the salient physiological characters of an organism which will be applicable in mycology. This is the final ideal of the quantitative method, and the development of this method is imperative if order is to appear from chaos.

II. *Educability of Fungi.*

A second concept to which attention may with profit be directed is that of the "educability of fungi" or the induction by suitable treatment of permanent modifications in their biochemical, morphological or other properties. The concept of the educability of the lower organisms is almost universally held either explicitly or implicitly by microbiologists, but rarely is it formulated as a general principle, and even more rarely expressed in concrete terms. A survey of the literature, however, and still more, personal contact with those investigators interested in the behaviour of the lower organisms, clearly shews that this concept permeates all thought and all consideration of the problems involved, and that the validity of many far-reaching conclusions is bound up with its truth. Every day bacteriologists attenuate or augment the virulence of cultures of pathogenic organisms by well-known technique, observe the fermentation of sugars by cultures which before treatment were unable to form the requisite enzymes, find pigment produced where no colour was originally. "Systematic cultivation of colon and typhoid bacilli in the hands of Twort, Penfold and others seems to have shewn that agglutination as well as fermentation characteristics can be artificially changed. Furthermore, colour producing organisms like the prodigiosus can be artificially changed to colourless strains, and it is well known that certain micro-organisms rapidly lose their virulence when cultivated, and that the virulence can only be brought back by passage through animals. Rosenow claims recently to have converted hemolytic streptococci into typical streptococcus viridans, pneumococcus mucosus, and pneumococcus-like organisms." The foregoing passage is quoted from one of the latest and best known treatises on bacteriology(15).

And in 1915 Massee(25) wrote "That parasitism on the part of fungi is an acquired habit has been fully demonstrated and is generally accepted," and earlier, "A saprophytic fungus can be gradually educated to become an active parasite to a given host plant..."

In his recently published work on "Fungi and Disease in Plants," Butler(5) has written: "Certain saprophytes have been found at times to become 'educated' into the parasitic life; that is to say, it has been found possible to develop a parasitic strain, or race, of a normally saprophytic species, capable of living even on healthy individuals of the host plant."

Pringsheim(34), Dobell(8), Eisenberg(10) and Vaughan(47) have within recent years drawn up careful summaries of the evidence relative to this question and references to the greater part of the literature will be found in their compilations.

At first sight the weight of evidence on which the concept of the educability of micro-organisms is based appears so overwhelming as almost to preclude doubt. But first-hand acquaintance with certain of the described phenomena, and a more critical examination of the literature of the subject, raise disquieting suspicions that possibly investigators have been too facile in their interpretations of the phenomena observed and over hasty in drawing general conclusions.

In the first place it is very necessary to have sharply in focus what we mean when we speak of educating organisms or of inducing permanent changes in their characteristics. The changes which have been recorded in the lower organisms are of two essentially different kinds. One consists of those alterations which are impermanent, their expression depending upon particular factors in the environmental conditions. This category includes all the expressions of the plasticity of organisms which have already been referred to as "modifications." Such modifications are strictly comparable with the "ecads" or growth variants of for example *Polygonum amphibium* or other plastic phanerogams. If the individuals are returned to their original environmental conditions they revert strictly to type.

The second category includes all those alterations—however small they may be—which take place in an organism and are then transmitted to subsequent generations even when these are again grown under the original environmental conditions. As illustrations of such changes the work of Twort(46) and of Revis(35) may be noted. The former found that certain colityphosus organisms were able to acquire the power of fermenting certain sugars if grown in them for a sufficiently long time, the change taking place slowly. In this manner he modified

dysentery bacteria (Kruse and Flexner strains) so that they were able to ferment saccharose: and he was able to train *B. typhosus* to ferment lactose and dulcite, the power being retained permanently.

Revis(35) investigated certain coli-typhosus organisms which produce both acid and gas when cultured in peptone-broth plus certain sugars or polyhydric alcohols, and was able gradually to acclimate these organisms to a medium containing 0·1 per cent. of malachite green. When returned to the original medium the organisms were found to have lost the power of producing gas though they could still form acid.

The best known case of fungal education is that described by Massee(25). Following out certain indications given in one of Miyoshi's(27) experiments Massee sowed spores of *Tricothecium candidum* on leaves injected with sugar solution and from the growths thus obtained re-inoculated other injected leaves. This was done for several generations of the fungus, after which spores from the last growth were sown on normal leaves and infection obtained. "This means that after twelve generations of the fungus, educated to grow in living *Begonia* by means of chemotactic substance—a solution of cane sugar—the faculty of parasitism had been acquired for this particular host plant." "The period of time required in this series of experiments for the conversion of a saprophytic fungus into a true parasite was twelve weeks, and the number of generations of the fungus amounted to sixteen." "By similar means a parasitic fungus can be induced to become parasitic on a new host."

The changes illustrated in the foregoing paragraphs are induced or educative changes of which the results were transmitted to offspring. The change is therefore one of genetic constitution. The difference between the two categories is very clearly expressed by Dobell(8) as follows: "Let us suppose that a given Bacillus is coloured red under normal conditions. By growing it and its offspring upon a new medium they become —let us suppose—colourless. If the organisms and their descendants when transplanted again into the original medium are again found to be red, then the change (loss of colour) is a *modification;* if, on the other hand, they are found to be now permanently colourless, then the change is a *mutation.*" It is the induced mutation, the permanent change in genetic constitution brought about under controlled conditions and at will by certain educative treatment, which is the subject of this consideration.

The possibility of such facile genetic change carries certain corollaries, which perhaps have not been envisaged with sufficient clearness or reasoned to their logical conclusions, by

those investigators who have lightly paid allegiance to the general concept: and brief attention may profitably be given to certain of these issues.

The great mass of evidence which we have at our disposal would appear to point to the fact that the essential physiological nature of an organism is a constant. Now the physiological constitution of an organism interacting with certain physico-chemical factors in a particular environment produces a certain resultant—the visible individual—the characteristic properties of which are described in terms of colour, size, shape, etc. If the physiological constitution and the environmental factors are both constants it follows that the resultant of their interaction must also be a constant however often it may recur. But if apparently identical physiological constitutions under apparently identical conditions produce two different resultants it must follow either

(1) That the conditions are not really identical but different, for otherwise things which are equal to the same thing would not be equal to one another.

Or (2) that for a similar reason the physiological constitutions are different, i.e., that some change in the ultimate physiological nature of the organism must have occurred.

A graphic expression may be given to this as follows:

Let a = the physiological constitution of an organism,
and let b = the constant environmental conditions;
then ab = the resultant of interaction which is the visible individual.

Now if $a \times b$ on one occasion produce "ab," and on another occasion produce some other resultant such as "x," it must follow that either or both a and b have changed from their original state into some different constants such as "c" or "d."

If this change be one in the environmental conditions the resultant is merely a "modification" and outside this discussion. If, however, the change be in the physiological constitution of the organism it is a fact of incalculable import, for it would mean that the physiological constitution of an organism could be altered at will, the facility and scope of change increasing with fuller knowledge and refined technique so that theoretically there is no limit to its operation. But the only foundation which we can find for any systematic categorisation of living organisms is in the absolute constancy of their physiological constitution, this being the ultimate specific criterion. If therefore one may at will transmute one physiological constitution into another, it follows that one can change one species into another species, and this with great rapidity, merely by the simplest adjustment of the most common environmental factors.

But it is perhaps not sufficiently realised that our culture media, our test tubes and flasks are but microcosms, and that the little experiments devised in laboratories have been carried out on an infinite scale by Nature for aeons of centuries. That whereas in laboratories we merely change a medium from saccharose to dulcite and back again, or raise the temperature by ten degrees or perform some other equally trivial operation, Nature offers to micro-organisms infinite permutations and combinations of all the physico-chemical factors operative on this earth. If therefore the little endeavours of human investigators may so easily change one species into another species, Nature must surely be doing this on an infinite scale. But to admit that species in Nature are unstable and labile, one instant moving in this direction, the next instant moving in that as the world adjusts itself is surely a *reductio ad absurdum*. Were it true a science of biology would be but a Utopian dream; more, we should not exist for evolution had been impossible.

On *a priori* grounds therefore such quick and facile changes in the ultimate physiological constitutions of organisms are not only inconceivable but frankly impossible, and some other interpretation of the observed phenomena must be found. Such interpretations are not far to seek for they can only lie in two directions.

(i) Either the environmental factors are inconstant in which case the apparently induced mutation is, as already stated, merely a modification, or

(ii) The change must exist in the organism but in some other form than a change of physiological constitution.

Recent investigations throw much light on the possible nature of this change, and attention may briefly be drawn to a few of the main lines of research which bear on this question.

The crux of the problem lies principally in the initial purity of the organism which is the subject of experiment, and in perhaps the majority of those investigations, the results of which are generally accepted as phenomena of induced mutation, it is here that the interfering factor is operative.

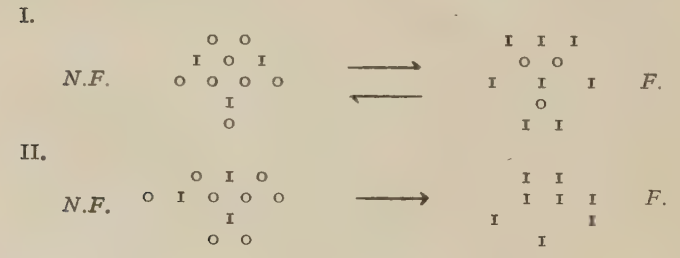
In the higher vegetable organisms, as in the fungi, there are "physiological species"—the "species" of Lotsy(23)—within the elementary species or "Jordanon"; and elementary species within the Linnean species or "Linneon." In bacterial categorisation morphological characters are but of little help and recourse is had to the physiological reactions of the organisms under standardised conditions, the bacterial species being diagnosed by means of cultural data. During the last few years it has been found that within the bacterial species there are, frequently, very nearly allied races, often only

differing in some obscure serological reaction, and extremely difficult to isolate. These correspond to the ultimate physiologically differentiated categories of fungi, and represent the "species" of Lotsy(23) which is the genotype in the phanerogams. These serological races harmonise perfectly in their growth and often exist as mixed populations. Many of the pedigree cultures which have been used in laboratories for years are such mixed populations, the component species existing side by side through numerous transplantations. It is only the recently devised and still largely neglected technique for the isolation of individual bacteria wherewith to initiate pedigree cultures, that furnishes hope of solution for this most embarrassing complication. The ordinary method of purification by dilution is practically valueless in such circumstances.

There can be little doubt that many of the "pure" cultures of organisms which have formed the basis for experimental researches on the induction of mutations, have not been absolutely pure species but mixed populations with unknown components. If therefore in these investigations the most critical factor—the initial organism—may be a mixed and unknown quantity, it does not seem wholly wise to build any fundamental and far reaching conclusions on the results obtained.

Moreover it is an elementary principle in scientific methodology that of two hypotheses, that which may be expressed in simpler terms, or in terms of more general applicability, should be chosen; and if one applies this to the phenomena in question, one finds that they may be brought within the scope of present hypotheses and paralleled by known facts.

There are few of these results which may not be explained in terms of the selection of components from a mixture, of species from a population. The classical work of Johannsen(19) on pure lines shewed the immense importance of this concept in the study of the higher organisms, and there are few aspects of biology to which the pure line concept has not made its way, although its influence is yet hardly appreciable in Mycology and Bacteriology. As applied to the lower organisms this concept may be shewn diagrammatically as follows:



III.

IV.

V.

A few words may be said about each of these conditions, which have been reduced to their simplest proportions.

In Case I a population consists of two species of which one is numerically dominant owing to the selective and favourable action of the medium. The second species may exist in almost infinitesimal numbers and therefore the characters of the colony are entirely those of the dominant form, which we may suppose to lack fermentative power. If now the conditions be gradually changed by the addition for example of lactose to the medium in increasing amount, the relative numerical proportions of the two species comprised in the colony may be reversed owing to this medium favouring the growth of the previously subordinate species. At the end of the "educative" treatment the characters of the colony will be those of the now dominant form which we may suppose to possess the power of fermenting sugars. The non-fermenting organism will still exist in the colonies but its influence will not be visible and thus the "organism" will by such treatment have acquired the power to ferment sugar. If the conditions be reversed an opposite process will occur and the original equilibrium be restored. This explanation is probably applicable to most of those instances in bacteriology and mycology where the virulence of a specific culture fluctuates, and it may explain results such as those obtained by Bernhardt and Markoff(4) in which blue colonies of *B. coli-mutabile* on Drigalski-Conradi agar gave rise to red colonies which if bred through mice and rabbits again became blue.

In Case II the population is again dominated by the non-fermenting species. By the cumulative addition of lactose however, the conditions may be so altered that the subordinate species becomes dominant and the previously dominant species dies out. Again the final result will be a colony able to ferment sugar but, whereas in Case I the action was reversible, in this

case the action may not be reversed for there is now no subordinate strain to select out. This explanation is probably common to many of those results where the change is permanent —that is the property once acquired by the race is never lost. This is well illustrated by an experiment of Horiuchi(16), who relates that he had in his possession a highly virulent, densely capsulated strain of the micrococcus tetragenus, which resisted phagocytosis *almost* entirely and killed guinea pigs in a dose of 100 organisms. When this was grown for a number of days on rather dry agar it lost its capsule-forming power permanently, became readily subject to phagocytosis, and did not affect guinea pigs even in doses of 1,000,000,000 organisms.

In Case III the non-fermenting organism is found to be absolutely ineducable by any treatment whatsoever. This is due to the fact that it is really a pure species, and not a population out of which a particular subordinate strain may be selected.

Case IV is the reversal of Case II. In the latter a character is developed by the selection from a population of a subordinate component possessing that character. In the former the population is originally fermentative but loses that capacity because the subordinate species which finally becomes dominant cannot form the necessary enzymes. As no individuals of the originally dominant species remain, the population becomes a pure line which is constant.

Case V corresponds to Case III, but the fermenting power is retained under all treatments.

In these five conditions and multiples of them, all possible educative phenomena may be included; and except in those investigations where the organism has been initially derived from a single individual, and subsequently the most rigid precautions adopted to eliminate possibility of contamination, it is more consonant with principles of scientific methodology to adopt a hypothesis stated in terms of the selection of existing species from a population, than a hypothesis which requires the introduction of such a new and fundamentally destructive idea as that of the fluidity of species.

That two or more fungal or bacterial species may grow together so harmoniously that the mixed nature of the culture cannot be detected save by the most scrupulous attention to a special technique is a fact that as yet is hardly receiving due recognition. Under most environmental conditions the two or more organisms "harmonise" perfectly in their growth but under the influence of certain other environmental factors they may "disharmonise" or shew characteristic divergencies, when the mixed character of the population becomes evident. This is the case with certain species of the "Linneon" *Botrytis*

cinerea Pers.: and experience in laboratories of medical pathology during the last two or three years has shewn that bacterial cultures which for years have been regarded as of specific purity, and regularly transplanted in the usual way, have in reality consisted of mixed populations, and that under the influence of unusual conditions the components have shewn characteristic and divergent reactions. It is absolutely imperative therefore that the experimental organism in all investigations dealing with the educability of micro-organisms should be above suspicion regarding its specific purity. Possibly in such a direction may be sought the explanation of the arresting claims of Rosenow(36) to which reference has already been made.

A second direction of research which may possibly throw a flood of light on the so-called mutations in the bacteria lies in the investigation of the life-cycles and developmental and reproductive phases of these organisms.

Since the days of Cohn(7), who established the morphological constancy of the bacteria, these organisms have been regarded as characterised by an extremely simple life-history, and although in the intervening period many observations have been put on record which have contravened this idea, the weight of dogma has been so heavy that these have not received serious consideration. There can be no doubt that progress in bacteriology has been very severely checked by the rigid adherence of all but a few investigators to a conventional conception of a very simple and constant bacterial organism. The recent researches of many workers, among whom may be particularly mentioned Hort(17) in this country, Löhnis and Smith(22) in America and de Negri(30) in Germany, indicate that the life-cycles of the bacteria may be very complex and characterised by the regular occurrence of many different forms and stages of growth connected with each other by constant relations. Under ordinary conditions simple binary fission and endospore formation are probably only two of many phases in the life-cycle which there would seem reason to believe includes an almost invisible filterable stage and a naked plasmodial or symplastic condition. According to Löhnis and Smith(22), "The life-cycle of each species of bacteria studied is composed of several sub-cycles shewing wide morphological and physiological differences. They are connected with each other by the symplastic stage. Direct changes from one sub-cycle into another occur, but they are rather rare exceptions."

The foregoing very brief sketch may give some idea of the hitherto unrealised complexities involved in investigations,

where very slight changes in morphology or biochemical properties have been acclaimed as the induction of a mutation. These mutations may be merely the expression of a developmental stage previously unrecognised; new phases may present new cultural reactions, and possess different biochemical properties. If the presence of sub-cycles within the general life-cycle be confirmed, such knowledge will go very far indeed to explain many of the phenomena hitherto regarded as evidence of mutation. Clearly until very much more is known of the full life-histories of the organisms upon which the experimental work is carried out it will, at least, be somewhat injudicious to found upon the results of such experiments any very fundamental conclusions.

Again a possible interfering factor which has received little or no attention by the bacterial mutationists is that of the genetic constitution of their organisms. In the higher animals and plants the almost bewildering complications which consideration of the gametic constitution of the individual introduce into any experimental study, where absolute specific purity is vital, render it imperative that the genetic relations of the subject to be investigated be known with the most scrupulous accuracy and in the minutest detail. If one is examining the morphological and physiological behaviour of a species of which such knowledge is totally lacking, and drawing therefrom phylogenetic deductions, those deductions, and conclusions based upon them, will tend to be unreliable.

Now the lack of information concerning the genetic behaviour of bacterial organisms is profound. Hitherto the only recognised reproductive processes have been those of binary fission and asexual spore formation. If analogies drawn from the behaviour of higher plants have any value, the recent investigations on somatic segregation may indicate that the genetic processes involved even in binary fission may have a significance greater than that with which they have been accredited. If in addition there are further possible avenues of segregation in such reproductive processes as gonidial formation and gemmation, this matter may assume a serious aspect.

Furthermore it is not inconceivable that in the bacterial life-cycle there may exist some phase more or less comparable with the sexual fusions of other organisms. Löhnis and Smith(22), for example, note a symplastic stage in which "the living matter previously inclosed in the separate cells undergoes a thorough mixing either by a complete disintegration of the cell wall, as well as cell content, or by a 'melting together' of

the contents of many cells which leave their empty cell walls behind them." In addition there was observed "another mode of interaction between the plasmatic substance in bacteria cells...consisting in the direct union of two or more individual cells. This 'conjunction' seems to be of no less general occurrence than the process first mentioned."

And these indications do not stand alone, for scattered through the literature there are many sporadic observations which point in the same direction. Without labouring this point further it may be stated that if at any time sexual phenomena be observed in the bacteria it involves the existence of heterozygous individuals with the possibility of segregation on Mendelian lines. Such segregation by the splitting up of a heterozygote might explain the so-called "reverting mutants"(50) in which the new form is described as constantly giving rise to two types of colonies one similar to the obvious parent and one like itself, the former breeding true, the latter again shewing segregation.

Whether or not these speculations contain any germs of truth, the fact remains that we are in total ignorance of the genetic constitution of a single bacterium, and this should make one hesitate before elaborating theories of great import which have their foundations in the processes of reproduction.

Finally there is the imperative need to exclude all possibility of contamination, or the "mutant" may merely represent an invading organism. If, as would appear probable, many bacteria may give rise to reproductive bodies so infinitesimally small that they will pass through a porcelain filter, it will be quite obvious that experimental technique must be very considerably more exact and nice if the results are to be worthy of serious consideration.

From the brief sketch which has been given of certain of the more important lines of research which bear upon the question of the educability of fungi and bacteria it will be clear that much of the evidence bears no relation to the point at issue, and that of the remaining investigations scarcely one may be accepted at its nominal value.

There are certain evident minimal requirements for any studies to this end which may perhaps be expressed as follows:

(1) In order to ensure specific purity the organism must be a single individual of a tested pedigree pure line.

(2) The whole life-history of the organism together with the range of its plasticity both morphological and physiological must be accurately known in the minutest detail.

(3) No organism in which sexuality exists or it is conceivable that it may exist must be used unless its gametic constitution,

and genetic behaviour under all the conditions of the experiment, be known.

(4) Possible contamination by filterable gonidia must be eliminated.

(5) Adequate control experiments must be maintained (a little matter, but one absolutely vital, which has escaped the attention of many students of the lower organisms).

Unless these five conditions are rigidly maintained in the focus of one's attention, and exactly complied with, the results obtained in experimental studies on the educability of micro-organisms can have but little value.

Much of what has been said is drawn from bacteriological investigation and few direct references to more strictly mycological studies have been made. There are two reasons for this. In the first place direct experimental work on the educability of fungi is confined to a very few investigations of which more will be said later, and the criticisms and suggestions which have been made apply equally both to bacteriological and mycological studies. In the second place the concept of the educability of micro-organisms had its birth in the laboratories of bacteriology, and largely in the phenomena of the attenuation of viruses of whose nature and organic composition nothing is known*. Thence it has been taken over by mycologists and applied to the fungi with a confidence and lack of critical evaluation which is somewhat astonishing.

Still, if this concept be true for the bacteria, it must also be true for the fungi. The whole of biological science is founded on the hypothesis that in their ultimate physiological constitution living organisms are constant, for otherwise it would be futile to attempt even the most general systematic treatment of individuals, which are the only forms in which the living organisms are known to us. This concept cannot be true for certain kinds of individuals and untrue for others, true for the bacteria and untrue for the fungi, applicable to ferns, inapplicable to liverworts. Biological science stands or falls by the truth of this concept, for without it there can be no systematised knowledge of living things.

A few words however may perhaps be said of the evidence derived from fungal studies which has been regarded as establishing this concept. The classical investigation is that of Massee(25) in 1905 to which reference has already been made. Even for that date this work was remarkable rather for what it

* Whilst this paper is passing through the press a study of acute infective polyneuritis has appeared which is noteworthy as containing a description of the minute organism composing the filterable virus causing this disease. (Bradford, J. R., Bashford, E. F. and Wilson, J. A., Quart. Journ. Med., 12, 1919.) See also the same authors in the Lancet, No. 4979, 1919.

omitted than for what it produced; and in the light of what has been said, and particularly of the minimal experimental conditions, fulfilment of which is obligatory in studies designed to elucidate this issue, this research possesses now only historical interest.

Evidence of much greater weight is the well-known work of Salmon(37) on the adaptive parasitism of *Erysiphe graminis* and the parallel results obtained for certain rust fungi by Ward(48), Freeman(12), Freeman and Johnson(13), Johnson(20), Pole Evans(33) and others. Until however this work can be carried out under conditions much more rigidly controlled, and with the nicety of technique which has been indicated as imperative to the present issue, these most interesting results must be placed on one side, and the verdict on the present question be regarded as "non-proven." Moreover it may be noted that the more recent work of Stakman(41), Stakman and Piemeisel(42), Stakman, Parker and Piemeisel(43) and Stakman, Piemeisel and Levine(43 a) has produced results which directly negative the conclusions previously reached. As a result of their investigations they state(43): "The results of the experiments with *P. graminis tritici-compacti* shew that barley which both theoretically and from the results obtained by previous investigators might be expected to increase the infection range does not do so. Even susceptible varieties of wheat do not change the parasitic capabilities of the rust so as to enable it to attack a normally resistant variety. Furthermore the rust does not acquire additional virulence when associated for a long time with a given host. Barley is moderately susceptible to the rust but the relations between host and rust are apparently the same regardless of the length of their association with each other. Wheats resistant to the rust remain resistant regardless of the previous history of the rust."

"In no case, however, was there the slightest evidence of any change in the virulence of the parasite, nor any indication that a short sojourn on a susceptible hybrid had given it any peculiar ability to cause normal infection on a heretofore resistant variety or to cause a more than usually virulent infection on a susceptible variety."

And again (43 a) "Differential hosts must be used to isolate biologic forms from mixtures before conclusive experiments can be made with bridging hosts." "No one so-called bridging host nor any combination of such hosts enabled any biologic form tried to infect naturally immune plants nor to infect a highly resistant plant more readily." "The writers have not been able to detect any mutation nor to induce perceptible evolutionary changes experimentally."

It will be evident from this very brief summary* of certain of the principal positive contributions to this subject, that the condition of knowledge and the available evidence is not such as to warrant the deducing of any, even minor, conclusions; much less the elaborating of a hypothesis so subversive of the foundations of biological science.

On the other hand there is a very great deal of evidence which shews that the properties of numerous organisms which have been investigated have remained constant under all treatment. This constancy of reaction to particular environmental conditions has been referred to in the first portion of this paper, and is the normal expectation. Conclusions such as those reached by Dox(9) from an intensive study of the intracellular enzymes of Penicillium and Aspergillus, and which are quoted below, could be multiplied almost indefinitely: "There is no evidence that enzyms not normally formed by the organism in demonstrable quantities can be developed by special methods of nutrition. The influence of adding a particular substratum to the medium is, therefore, not to develop any entirely new enzym, but to stimulate the production of the corresponding enzym, which is normally formed under all conditions."

In my own studies of *Botrytis cinerea* I have only been able to educate this fungus when the initial culture has represented a mixed population, and the extent of possible educability is equal to that of the particular component possessing the required property in the highest degree. When this strain has been selected out from the population, and is dominant, the organism or culture shews no further capacity for education. A culture of *Botrytis cinerea* which contains a single strain only, i.e., an organism which is of specific purity, cannot in my experience be educated or permanently modified in any direction.

When one considers this concept of the educability of micro-organisms, and realises how pregnant with significance it is for all aspects of biological science, how implicit is the allegiance paid to it almost universally by students of microbiology and how its far-reaching ramifications permeate all thought and influence all technique in these studies, one feels that surely its roots must lie deep in fact, and its truth be unimpeachable.

* Reference should also be made to the work of Miss E. Schiemann on mutations in *Aspergillus niger* (Zeit. f. indukt. Abstamm. v. Vererbungslehre viii. 1912). Colour modifications in this fungus may readily be produced but Miss Schiemann's work stands alone in that the induced changes were permanent. Until the circumstances obscuring the genetic constitution of this fungus are made more clear, and the results are confirmed under more rigidly controlled conditions, one must hesitate in accepting this unique work. My own repetition of these experiments has given absolutely negative results.

But if one then surveys the available evidence, critically evaluating the phenomena which have been recorded or the interpretations which only too frequently have been set down in their place, one is left with a feeling of utter dismay.

A hypothesis of little moment, merely a corollary to a well-established theory, we may accept on slight positive evidence, but acceptance of a fundamental concept of wide and subversive applicability is in a totally different category. This must be based on a great mass of critical and sifted evidence, positive, convincing and amply confirmed.

In the foregoing pages the endeavour has been to shew that the concept of the educability of micro-organisms has not arisen in such evidence, and that beyond high authority and much prestige there is little to favour its retention as a fundamental concept of microbiology, save the dead weight of convention and inertia.

In this brief discussion of the "species-concept" and the "concept of educability" in mycology, no attempt has been made to review the literature cognate to these issues, for to have outlined even the principal investigations would have rendered such a preliminary consideration as this wearisome to read and of unwieldy length. All that has been feasible here is merely to indicate certain lines of thought, largely the result of one's own observations but owing much to one's past and present colleagues, which do not appear to coincide with conventional beliefs.

The present epoch of the science of mycology had its birth about the middle of the nineteenth century in the labours of de Bary, Woronin, Berkeley, Zopf, Brefeld, Nägeli and others too numerous to mention, and in the period represented by the great treatises of de Bary and of Zopf the fundamental concepts dominating mycology were elaborated. These hold to-day, and since that time few concepts of major importance have been formulated. And yet the last three decades have seen the birth and development of the experimental attitude and the cultural technique; and in this period there has been accumulated a mass of fact greater in volume than the stores of eighteen centuries. It is a mass of analytic data which we try to interpret according to the concepts and ideas of an earlier time. And still we accumulate unco-ordinated observations and heap up an incoherent literature. In the great scientific renascence of the nineteenth century, mycologists were not content merely with unending analysis, they also synthesised. We use their syntheses to-day.

The great present need, not only of mycology, but of all biological science, is Synthesis. Let us make bricks and

mortar, but let us also build houses. We still live in the houses the giants of last century built for us; but our possessions overflow. There are great heaps of bricks lying around and instead of using them we merely pile others on the top.

Synthesis may not be the work of one man, for the labour would be too great, but if many help, a fair and useful structure may arise.

The present paper is a very tentative essay towards synthesis in mycology. Two out of many possible lines of construction have been followed and it is hoped that others may criticise and co-operate in the building.

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CHARLES OGILVIE FARQUHARSON.

By E. M. Wakefield, F.L.S.

In the list of passengers missing after the loss of the s.s. "Burutu," homeward bound from West Africa, on the night of October 3rd, 1918, occurred the name of Charles Ogilvie Farquharson, M.A., B.Sc., Mycologist to the Agricultural Department, Southern Provinces, Nigeria. C. O. Farquharson was born at Murtle, Aberdeenshire, in February, 1888, and was educated at Robert Gordon's College, Aberdeen. From there he entered the University, in 1905, and at first intended reading for the Honours Degree in Classics. At the end of his second year, however, he decided to devote himself to Natural Science. After graduating in Arts he took the Science course, and gained his degree of B.Sc. in 1911, with special distinction in Botany. Shortly afterwards he came to Kew, and worked for a few months at Mycology and Plant Pathology under the late Mr. G. Massee. He was appointed Mycologist in South Nigeria, and sailed in the beginning of 1912.

The multifarious duties which fall to the lot of officers in Colonial Agricultural Departments did not leave him much leisure for purely mycological work. He was, however, keenly interested in the subject, and in the intervals of acting as Assistant Director, Entomologist, or Agricultural Inspector, as occasion demanded, he was able to collect fungi to some extent, and accumulated a fund of information with regard to plant diseases in West Africa. In a letter to the Assistant Director at Kew, dated September 23rd, 1918 and sent by the mail following the ill-fated vessel on which he sailed, he gave a graphic summary of his work, discussing the problems to be faced, and the kind of training his experience had led him to believe best for such work. This letter, which was published in the Kew Bulletin, No. 10, 1918, is of general interest to all concerned with tropical plant pathology. His sound judgment renders his views worthy of close consideration.

The letter shows that he had a strong presentiment that he might not reach home. His botanical friends mourn the loss of a very charming personality, as well as of a mycologist who promised to have a useful and distinguished career. Unfortunately much of his detailed knowledge is lost with him, as partly through modesty and partly through lack of time he had published little. Mr. Farquharson sent home to Kew

a number of interesting fungi, with full ecological notes. Lists of these were published in the Kew Bulletin, No. 7, 1914, p. 253, and No. 3, 1917, p. 104. In the Journal of Botany, 1916, p. 121, he published in conjunction with Miss G. Lister an account of South Nigerian Mycetozoa, in which two new species, *Physarum digitatum* Lister and Farq., and *Dichaea radiata* Lister and Petch, are described. His only other published mycological work is contained in the official reports of the Mycologist for South Nigeria.

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